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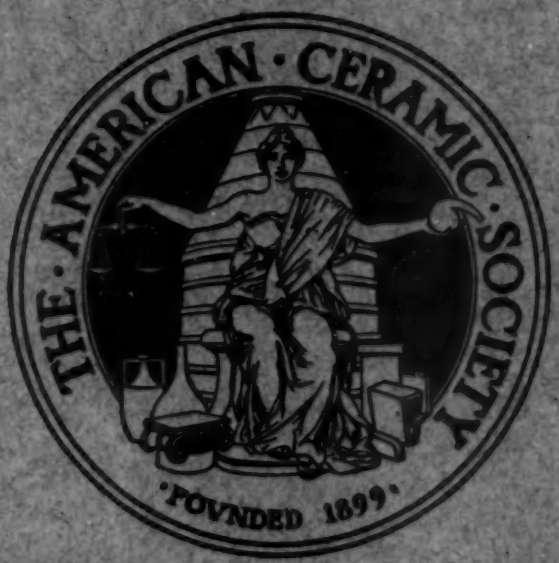

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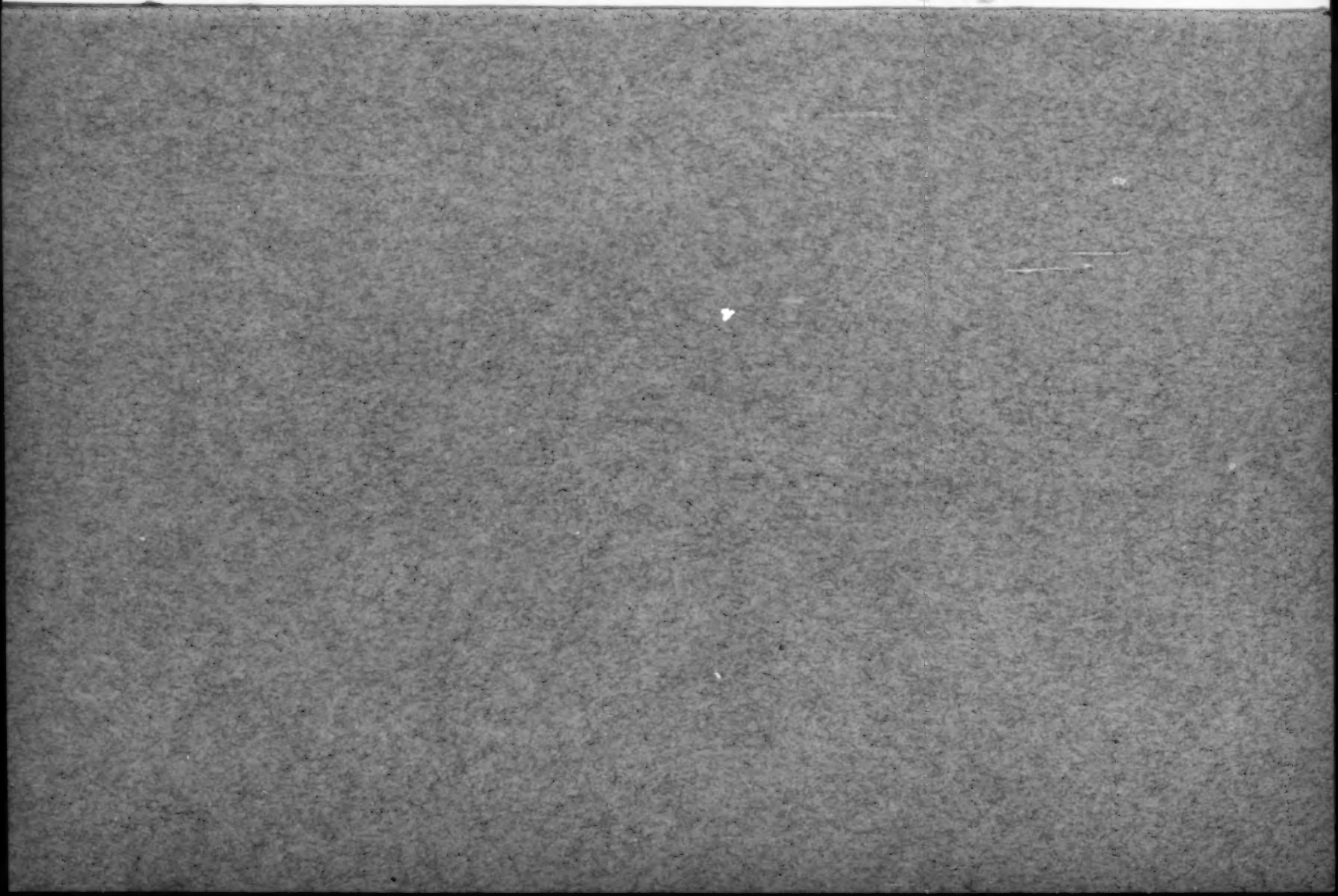

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NOTES ON THE X-RAY DIFFRACTION PATTERNS OF MULLITE*

By E. Posnjak and J. W. Greig

ABSTRACT

A wide range of artificial alumina-silica products has been examined by the X-ray powder method. In each case in which the pattern has been sufficiently clear to permit a decision the pattern has been that of mullite, not that of sillimanite. The examination included a number of preparations made by heating clay minerals and clays at 1000°.

Mullite crystals containing alumina or the oxides of iron or titanium in solid solution give diffraction patterns in which the lines are slightly displaced toward the origin with respect to the corresponding lines in the diffraction pattern of the standard mullite ($3Al_2O_3 \cdot 2SiO_2$).

Mullite crystals, freed by HF treatment from the matrix in which they grew, often give diffraction patterns in which the intensities of certain lines are strikingly different from normal. This is due to the orientation of the minute elongated crystals when mounted for photographing.

Finally, two recent papers proposing special names for certain similar materials are discussed and, on the basis of published data and the evidence presented here, these proposals are found to be unwarranted.

I. Introduction

Two papers dealing with the nature of the aluminum silicate that is formed in ceramic materials at high temperatures have recently appeared. In one of these it is stated, on the basis of X-ray diffraction data, that the crystals formed in porcelains are not mullite, and a new name is applied to them. The other paper, dealing with the effect of heat on clays, is less definite, but it also advances a new name for the crystals formed at high temperatures. In view of the interest that this subject has for the members of this Society the Chairman of this Symposium, cognizant of some work that we had done, requested us to comment on these papers. It seemed to us that some of the information resulting from our work is relevant to the questions raised by these papers, so we have accepted his invitation. In accordance with the scope of this Symposium this paper will be confined chiefly to the presentation of certain X-ray data and, with this as a background, to comment on the two papers under consideration.

In introducing this Symposium, Dr. Sosman has reviewed the information at present available about the two-component system, Al_2O_3–SiO_2. Our knowledge of the behavior of mixtures of these oxides at high temperatures is, in large measure, due to the work of Bowen and Greig on the equilibrium relationships in this system.[1] In this work they found that the only compound of alumina and silica stable at high temperatures was not sillimanite, as had generally been supposed, but a compound closely resembling sillimanite in its physical properties. To this compound

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* Presented in the Second Symposium on the Physical Chemistry of the Alumina-Silica Refractories at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (Refractories Division). For the papers in the First Symposium see *Jour. Amer. Ceram. Soc.*, **16** [1], 54–76 (1933). The first group of papers belonging to the Second Symposium was published in the September issue of the *Journal*, p. 412.

[1] Four papers have been published summarizing this work: (*a*) N. L. Bowen and J. W. Greig, "The System Al_2O_3–SiO_2," *Jour. Amer. Ceram. Soc.*, **7** [4], 238–54 (1924); **7** [5], 410 (1924); (*b*) N. L. Bowen, J. W. Greig, and E. G. Zies, "Mullite, a Silicate of Alumina," *Jour. Wash. Acad. Sci.*, **14**, 183–91 (1924); (*c*) J. W. Greig, "Formation of Mullite from Cyanite, Andalusite, and Sillimanite," *Jour. Amer. Ceram. Soc.*, **8** [8], 465–84 (1925); *Amer. Jour. Sci.*, [5], **11**, 1–26 (1926); (*d*) R. W. G. Wyckoff, J. W. Greig, and N. L. Bowen, "The X-Ray Diffraction Patterns of Mullite and Sillimanite," *ibid.*, pp. 459–72 (1926).

they assigned the formula, $3Al_2O_3 \cdot 2SiO_2$.[2] Shortly after this they found that the same compound occurred as a mineral in a rock on the Isle of Mull and accordingly named it mullite.

II. Mullite Series of Solid Solutions

(1) Oxides of Iron and Titanium

From the examination of this natural mullite and of mullite crystals from a number of technical products Bowen and Greig found that mullite, growing in a medium containing the oxides of iron and of titanium, took these oxides into solid solution, and that the physical properties of the mullite crystals were correspondingly modified. The indices of refraction of the mullite crystals were raised by these oxides, approaching those of sillimanite, and at the same time a pronounced pleochroism developed.[15] It was expectable that the X-ray diffraction patterns given by such mullites would differ

TABLE I

List of natural and technical materials that have indices above those of the standard mullite and that gave X-ray diffraction patterns in which the lines were slightly displaced toward the origin with respect to the corresponding lines in the pattern of standard mullite.

(1) Natural mullite from Seabank Villa as analyzed by Zies.[15] X-rayed without leaching with acid, and the separated crystals also X-rayed against the standard. The mullite lines are displaced toward the origin and the separated crystals show intensity changes like those noted on p. 577 and shown in Fig. 5.

(2) Nun's Pass mullite separated from the matrix, taken against standard mullite. Lines of mullite displaced slightly toward the origin and intensity changes like those noted on p. 577 and shown in Fig. 5.

(3) Crystals occurring in refractory, supplied by G. V. Wilson, that was strongly colored by presence of iron. These crystals have indices of refraction approaching those of sillimanite, yet unlike sillimanite they show a strong pleochroism and are not decomposed by heating. Remnant of material used by Bowen, Greig, and Zies[15] (pp. 189–90); crystals X-rayed in the glass in which they grew, compared directly with standard mullite; displacement of lines toward the origin, tridymite present. Crystals separated from the glass by HF compared directly with the crystals in the glass; intensity changes like those described on p. 577 and shown in Fig. 5.

(4) "Salamander" from the hearth of a blast furnace at the Sparrows Point plant of the Bethlehem Steel Co. The material was originally a high-grade fireclay product. Both graphite and metallic iron occur with the mullite crystals. X-rayed against the standard without removing the crystals from the matrix. A displacement of the lines toward the origin (see Fig. 1).

(5) Boiler-furnace slag received from F. P. Hall, Bureau of Standards, Columbus, Ohio, through the courtesy of Herbert Insley. X-rayed against standard mullite. Displacement of the lines toward the origin (see Fig. 1).

It is of interest to note that in each of the above cases the displacement of the lines was toward the origin. This was also the direction of the displacement in the case of solid solution of Al_2O_3.

from that given by the $3Al_2O_3 \cdot 2SiO_2$ material. This we have found to be the case. X-ray powder photographs have been taken of some of the materials collected and used by Bowen and Greig and of some additional similar materials. In each case the material was compared directly with the

[2] This compound had been discovered many years before by Sainte-Claire Deville and Caron, who synthesized and analyzed it (*Ann. chim. phys.*, **5**, 114 (1865)). Vernadsky had also found that the small sillimanite-like crystals of Sèvres porcelain had not the correct composition for sillimanite. He assigned to them the formula, $11Al_2O_3 \cdot 8SiO_2$, a composition close to $3Al_2O_3 \cdot 2SiO_2$ (*Bull. Soc. Franc. Mineral.*, **13**, 270 (1890)). Cox had also found that crystals grown in a fireclay refractory were close to those of Vernadsky in composition and had accepted Vernadsky's formula for them (*Geol. Mag.*, **5**, 61 (1918)).

standard mullite[3] by taking the photographs side by side on the same film (see Table I). In each of these cases the mullite crystals have had indices of refraction above those of the standard, and in each case the lines on the powder photograph are slightly displaced with respect to those due to the standard without, however, any evidence of intensity changes. This displacement is toward the origin, and corresponds to a slight increase in the interplanar spacings of the crystals. Examples are shown in Fig. 1, where it will be seen that the lines in the powder photographs of the solid solutions lie slightly to the left of the corresponding lines given by the standard mullite.

(2) Alumina We have also found that a small amount of alumina may enter into the crystals in excess of the 3:2 ratio (Al_2O_3 71.8%, SiO_2 28.2%). Crystals having a composition near 75% Al_2O_3, 25% SiO_2

FIG. 1.—(1) and (3) Standard mullite ($3Al_2O_3 \cdot 2SiO_2$); (2) material from slag coating on the fireclay refractory of a boiler furnace; (4) "salamander" from hearth of blast furnace, originally high-grade fireclay refractory.

[3] This is the material prepared by Bowen and Greig in their original work and used by them to fix the composition of the compound. It was made by grinding together alumina and silica and firing them at a temperature not far short of 1700°, repeating the process until the product was essentially homogeneous.

FIG. 2.—(1) Preparation made by repeated heating (at about 1700°) and regrinding, until optically essentially homogeneous, of a mixture of 75% Al_2O_3 and 25% SiO_2; (2) standard mullite ($3Al_2O_3{\cdot}2SiO_2$: 71.8% Al_2O_3, 28.2% SiO_2) made as above.

by weight were prepared by grinding together the purified oxides in this proportion and firing the mixture at 1700 to 1750°, repeating the process until the product was essentially homogeneous as shown by microscopic examination. An X-ray powder photograph of this material, compared directly on the same film with that of the standard mullite, showed a small but definite displacement of the lines in the same sense as that noted above due to solid solution of iron or titanium. This is shown in Fig. 2 where the lines are seen to be slightly displaced to the left of the corresponding lines of the standard. The limit of solid solution at this temperature has not been exactly fixed, but the indications are that it is not far from this composition.

III. Range of Materials Studied

It may be of some interest, because of the announcements recently made of the discovery of new compounds, to outline the range of conditions under which the materials that we have examined by the X-ray method have been formed.

In connection with their study of the equilibrium relationships Bowen and Greig tried, by working at lower temperatures, to determine the relationship between sillimanite and mullite. It is not feasible to fix the composition of crystals by synthesis at these lower temperatures: it is neither practicable to prepare a glass of alumina and silica in the necessary ratio, nor, at these temperatures, to homogenize a mixture of silica and alumina.

They prepared crystals in a number of ways over a wide temperature range. By working with siliceous glasses containing oxides other than alumina added to lower the liquidus temperature, they grew crystals at temperatures down to 1050° that were large enough to remove from the glass by leaching with HF. The indices of refraction of all these crystals showed that they were mullite, not sillimanite.

We have taken powder photographs of a number of their preparations and of some additional ones. The temperatures at which the crystals were grown ranged from 1000 to 1800°, and the compositions of the ma-

terials in which they were grown have likewise varied greatly. These materials have included different binary mixtures of alumina and silica, glasses made from alumina and silica plus one or more other oxides, aluminum-silicate minerals, clay minerals, and mixtures of clay and feldspar. The writers have also X-rayed crystals made in an atmosphere of SiF_4

TABLE II

Samples of the following porcelain tubes were powdered and X-rayed. The material used was exactly as received from the manufacturer; it was neither heated by us nor treated with acid.

(1) Pyrometer protection tube of "McDanel-Impervite," made by McDanel Refractory Porcelain Co., obtained from Chas. Engelhard, Inc.
(2) Tube of "Champion Sillimanite 6060" made by Champion Porcelain Co.
(3) Tube of "Montgomery Mullite" made by Montgomery Porcelain Products Co.
(4) Tube of Marquardt porcelain made by the Royal Porcelain Factory, Berlin (pre-war).

All four gave the typical mullite pattern. Except for slight differences of spacing, probably due to small amounts of solid solution, these patterns are indistinguishable from each other and from that of our standard mullite (see Fig. 6). The first two gave patterns quite free from corundum lines, while 3 and 4 show corundum lines in addition to the mullite pattern.

TABLE III

SYNOPSIS OF X-RAY DATA ON MATERIALS HEATED AT 1000°

Original material	Notes on spectrograms
A	
(1) Homogeneous glass: 53% Al_2O_3, 44% SiO_2, 3% Na_2O	Sharp mullite pattern + lines of cristobalite (see Fig. 3). Mullite pattern indistinguishable from that given by the standard mullite
B	
Naturally occurring aluminum silicate materials arranged in order according to the quality of the mullite pattern given.*	
(2) Beidellite (leverrierite), Silver City, Idaho	Good mullite pattern + high temperature cristobalite lines (see Fig. 4)
(3) English china clay, Cornwall district	Good mullite pattern, lines of Al_2O_3 also present and probably some of cristobalite
(4) Pyrophyllite	Mullite pattern + lines that have not been identified
(5) Dickite, Red Mt., Colorado	Mullite pattern; lines of γ-Al_2O_3 also show
(6) Kaolin, Edwards County, Texas	Strong γ-Al_2O_3 pattern, lines probably due to mullite or sillimanite present but too faint to permit a decision
(7) Standard sample Zettlitz kaolin	Only the strongest lines of the mullite or sillimanite pattern show; γ-Al_2O_3 lines are very faint
(8) Anauxite, Franklin, North Carolina	Strong γ-Al_2O_3 pattern, lines that may be due to mullite or sillimanite are very faint

In the cases (1), (2), (3), (4), and (5) the pattern is definitely that of mullite, not of sillimanite. In cases (6), (7), and (8) the pattern is not well enough developed to permit a decision as to whether the phase is mullite or sillimanite, or to identify it on this basis alone as due to either of them.

Heat treatment: Numbers (1), (2), (3), (4), (6), (7), and (8) were heated over night at 940°, then 13 days at 997 to 1000°C. Number (5) was heated 37 days at 997 to 1000°. This material was also examined after having been heated for 7 days and after having been heated for 24 days at the same temperature. The results were the same except that the additional heating resulted in a stronger pattern.

* We are indebted to Herbert Insley of the U. S. Bureau of Standards for several of the clays used, including the English china clay from which Dr. Insley had previously obtained a mullite pattern after heating it at 1000°.

FIG. 3.—(1) Standard mullite ($3Al_2O_3 \cdot 2SiO_2$); (2) crystals of mullite and small amount of cristobalite in glass formed at 1000°.

by the method of Sainte-Claire Deville and Caron and those occurring naturally on the Isle of Mull. At one time or another a number of technical products such as porcelains and alumina-silica refractories, both new and used, have also been X-rayed. The diffraction patterns, when sufficiently well developed to permit a decision, have always been indistinguishable from the pattern given by the standard mullite except for slight displacements of the lines like those that are to be attributed, as has been shown above, to solid solution. In no case has the pattern been like that of sillimanite. There is no point in elaborating this. It is in agreement with the data obtained by many investigators using similar methods.[4]

Because the products obtained at the lower temperatures are the most interesting in this connection, in Fig. 3 is shown a powder photograph given by crystals grown at 1000°. The material used for Fig. 3 was prepared from a homogeneous alumina-silica glass, containing 3% of Na_2O, by heating it for three weeks. During this heating it partially crystallized. The pattern is compared directly with that given by the standard mullite and is indistinguishable from it except for some extra lines that are due to cristobalite which crystallized from the glass together with the mullite.

The result of heating clays, although of less direct bearing on the system Al_2O_3–SiO_2, is probably of greater interest to ceramists. While we have made no systematic study of the changes that take place in clays on heating, we did, some time ago, heat several clays and clay minerals. It was found after heating them three weeks at 1000° that the strength and sharpness of the diffraction pattern obtained varied greatly depending on the type of clay used. The best pattern was given by the product of the beidellite type of clay. In Fig. 4 the pattern given by this

[4] L. Navias and W. P. Davey (*Jour. Amer. Ceram. Soc.*, 8 [10], 640–47 (1925)) were the first to establish a difference between the X-ray diffraction patterns of mullite and sillimanite and, having established this difference, to reach a decision *by this method* on the crystals of calcined clays. Since that time the literature on the subject has expanded rapidly. No attempt will be made to summarize it here.

FIG. 4.—A(1) standard mullite ($3Al_2O_3.2SiO_2$); A(2) beidellite (leverrierite) clay, heated three weeks at 1000°, shows that mullite and high-temperature cristobalite have formed.

B(1) sillimanite, Delaware Co., Pa.; B(2) beidellite (leverrierite) clay heated three weeks at 1000°. Same preparation as above to show that diffraction pattern is different from sillimanite but identical with mullite as shown in A.

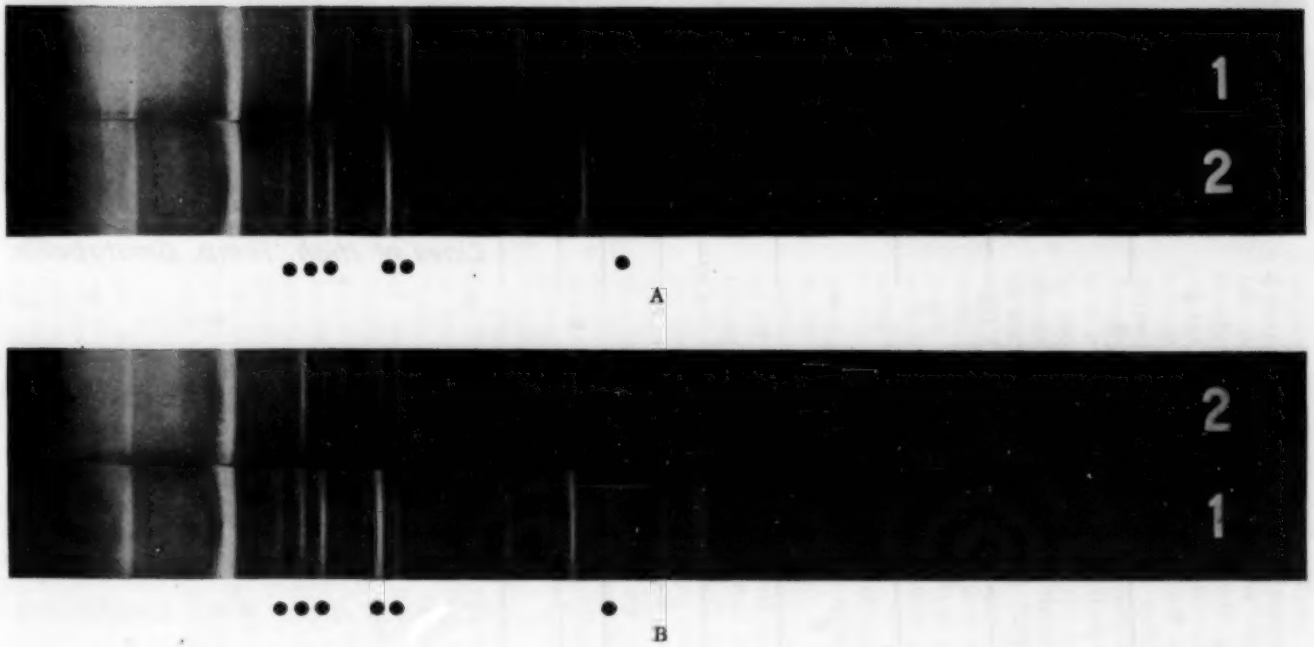

FIG. 5.—A(1) mullite crystals grown in a siliceous glass at 1200 to 1300°, and then removed from glass by leaching with HF; lines marked below show the more pronounced changes of intensities due to orientation; A(2) standard mullite ($3Al_2O_3 \cdot 2SiO_2$).

B(1) mullite crystals in glass made at about 1700° from mixture of pure silica and alumina in the molecular ratio of 1:1; B(2) same material after leaching with HF, and now free from glass. Lines marked below again show the more pronounced intensity changes due to orientation.

material is compared directly with that given by sillimanite and with that given by the standard mullite. The comparison shows that the pattern is not that of sillimanite but is the same as that given by mullite. A few extra lines appear in the pattern. These are due to the high-temperature form of cristobalite[5] which crystallized together with mullite from the original beidellite.

The data on other clays are summarized in Table III, and need not be commented on here except to say that in each case in which the pattern is sufficiently well developed to permit a decision the pattern is that of mullite, not of sillimanite.

NOTE: These data appear to be in general agreement with those of several other workers. Hyslop and Rooksby made a very careful study of the crystalline break-up of kaolin (*Trans. Ceram. Soc.* [Eng.], **27**, 93–96 (1927–28)) and found that crystals, that from their X-ray diffraction pattern might be either sillimanite or mullite, began to form together with another phase below 1000°, while, at temperatures above 1060°, the pattern became well defined and was clearly that of mullite. After the publication of the diffraction pattern of γ-Al_2O_3 by Hansen and Brownmiller they were able to identify the second phase as γ-Al_2O_3. This phase slowly disappeared when the material was heated above 1060°, without the appearance of lines corresponding to α-Al_2O_3. For this reason they considered that the alumina was combining with the other phase to form mullite and that the other phase had therefore been sillimanite (*Trans. Ceram. Soc.* [Eng.], **27**, 299–302 (1927–28)). It is to be noted that the better developed of our patterns were not obtained from kaolin (see Table III); moreover, the supposed sillimanite was not actually identified as such by Hyslop and Rooksby, so that there is no discrepancy in the actual data.

IV. Effect of Orientation of Crystals on the Diffraction Pattern

We come now to consider a variation in the character of the diffraction patterns that is due, not to any variation in the properties of the mullite crystals themselves, but to variations in the way they are handled.

Except when prepared in special ways mullite crystals are embedded in some matrix. This is the case in porcelains, fireclay refractories, rocks, etc. To determine their chemical composition or optical properties, or to concentrate the crystals for X-ray examination, investigators, following Vernadsky, have commonly dissolved the matrix in hydrofluoric acid followed by other acids. These separated crystals, when mounted for photographing on a silk thread, have usually given us a pattern that is distinctly different from that given by the same crystals before being extracted from the glass or other matrix. Examples are shown in Fig. 5. The differences are for the most part differences in the relative intensities of certain lines. This effect we consider is due to the assumption, by the separated crystals, of a preferred direction when they were being mounted for photographing, resulting in the increase of the total area of certain crystal planes suitably oriented to give diffraction lines and a decrease in the area of others.

The photographs shown in Fig. 5 were made by mixing the powder with celluloid solution and painting it on a fine silk thread. The crystals used to give the upper photograph are narrow needles varying in diameter from 3 microns down to about one-tenth of this and being some 10 or 15 times as long as they are wide. A microscopic examination of the coating on the thread prepared for photographing showed that the crystals were very

[5] Other cases in which cristobalite has been grown at high temperatures, dispersed in some medium, and has failed to invert on cooling have been described by Greig, *Jour. Amer. Ceram. Soc.*, **8** [4], 465–84 (1925); *Amer. Jour. Sci.* [5], **11**, 1–26 (1926); *Jour. Amer. Chem. Soc.*, **54**, 2846–49 (1932).

well lined up. To avoid this orientation, the same material was put dry into a glass tube, about 0.5 millimeter in diameter, and rotated during exposure. This gave a pattern almost[6] exactly like that of the standard mullite. That such crystals coating the thread should not have a random orientation is in no way surprising. It may, however, be somewhat surprising that crystals, such as those used for the lower of the two pairs of pictures in Fig. 5, should give such striking intensity changes due to this cause. These crystals are quite blocky, the lengths being only some 2 to 4 times the cross-sectional diameter.

Nearly all mullite crystals that we have had occasion to X-ray, when separated from the matrix, have given this effect to some degree when mounted on a thread. Two exceptions may be noted. The crystals used to prepare the lower pair of Fig. 5 were grown in a glass at about 1700°. They are thickly distributed in the glass, and with random orientation. Those showing the effect of orientation were freed from glass by using strong acid. Another lot separated by weaker acid, did not, however, show this effect. The differences are that, seen under the microscope, the second preparation shows many knots of crystals in contact, still grown together in the random positions in which they grew in the glass, also many small crystals have survived the treatment with the weak acid, while all such were dissolved in the stronger acid, which also has dissolved away the mullite at the junctions of the crystals that were originally grown together in knots. This material, painted on the thread, gave a pattern indistinguishable from that of the standard mullite. The other exception was similar, the crystals being still more blocky.

Wyckoff noted this effect of orientation in changing the relative intensity of the diffraction lines when he was working on the diffraction patterns of mullite and sillimanite, and drew attention to it on pages 461 to 462 of his paper.[1d]

The effect on the crystals of leaching in strong acid may not in all cases, however, be confined to freeing them from the matrix with some incidental solution. One of our photographs of such material shows a slight displacement of the diffraction lines away from the origin. This displacement is too slight to justify any conclusion, but is suggestive of some effect on the crystals due to the acid in this case.

V. Discussion of the Report of New Phases by Bradley and Roussin

With this brief report on the variations of the X-ray diffraction pattern of mullite as a preliminary, we may turn to the discussion of the papers under consideration.

Bradley and Roussin,[7] in a paper entitled "An X-ray Study of Porcelains and Their Relation to Mullite," on the basis of X-ray powder photographs, have announced the discovery of a whole series of different materials of sillimanite-mullite type, each with a slightly varying crystal structure. The existence of four very stable forms they regard as "definitely established." It will be convenient to consider their materials in the four groups into which they have classified them on the basis of the diffraction patterns.

[6] The difference is in extra lines that are probably due to impurity adhering to the surfaces of the crystals. These extra lines were also present in the photograph showing the changes of intensity due to orientation.

[7] A. J. Bradley and A. L. Roussin, *Trans. Ceram. Soc.* [Eng.], **31**, 422 (1932).

(1) Bradley and Roussin Standard Mullite As standard mullite they selected "pure artificial mullite supplied by an American firm." They found that "pure artificial mullite supplied by a British firm" gave the same pattern as did a sample of "natural mullite from North America" and one sample of "natural mullite from the Isle of Mull, Scotland."

(2) "Porzite" in Porcelain They examined a number of porcelains and found that all gave similar diffraction patterns. They prepared a number of materials by heating various mixtures made from clay, feldspar, sillimanite, and alumina, and found that when heated all developed crystals giving the same pattern as that given by the porcelains. This pattern they found different from that given by the first group. They say, "it is clear from the photographs that the fibrous material of porcelain can not be either sillimanite or artificial mullite. It should therefore be described by a distinctive name. The word 'porzite' is suggested for this purpose."

Assuming for the moment with Bradley and Roussin that the crystals of groups I and II are of different species, the question immediately arises which species, if either, should be identified with the material found by Bowen and Greig in their work and named by them "mullite." They have chosen to regard the "pure artificial mullite supplied by an American firm" as mullite and to use it as a standard although the only reason advanced for this choice would seem to be the label.[8] They regard as "particularly significant" the fact that they obtained this "porzite" pattern from the product resulting from heating a mixture of "pure sillimanite" and alumina in exactly the ratio to give $3Al_2O_3{\cdot}2SiO_2$, the composition assigned by Bowen and Greig to mullite. If this material was homogeneous when the heat treatment was complete what could it possibly be but the material named mullite by Bowen and Greig, and what else are all the other crystals giving the same pattern and called "porzite"? If the product was not homogeneous, wherein does its special significance lie?

NOTE: A description, illustrated with photomicrographs, of the behavior of sillimanite when heated has been given by Bowen and Greig[1a] and by Greig.[1c] When heated to high temperatures it breaks up to form mullite plus glass. The reaction with alumina is slow and corundum once formed is but slowly used up, so that attaining a close approach to equilibrium may be a long process. In synthesis it is only when the product has become homogeneous that the composition of the crystals is given by the total composition of the mixture. This condition can only be determined by careful microscopic examination. In most cases sufficient impurity is present to prevent *complete* homogeneity from being attained, but when the amount of impurity is low enough so that the resulting additional phase (or phases) is present only in small amounts that may be estimated, the composition of the crystals may be fixed within limits in this way.

The best example of the "porzite" pattern was obtained by Bradley and Roussin from a pyrometer tube supplied by "an American manufacturer."

We have taken X-ray spectrograms of three American porcelains and

[8] These crystals were obtained by Taylor for his work on the structure of mullite from G. S. Fulcher of the Corning Glass Works. No analyses of the crystals are given by Taylor or by Bradley and Roussin.

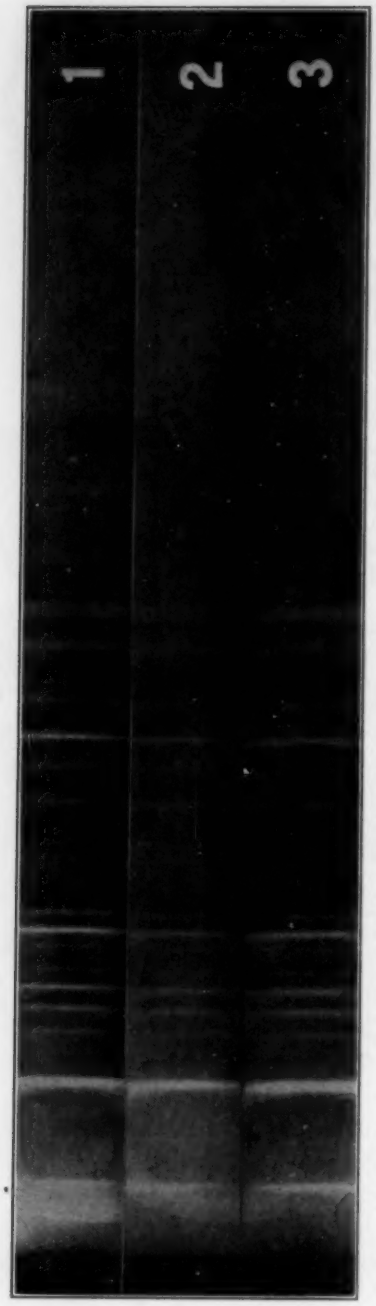

FIG. 6.—(1) Standard mullite ($3Al_2O_3 \cdot 2SiO_2$); (2) "McDanel-Impervite" pyrometer protection tube, obtained from Chas. Engelhard, Inc.; (3) "Champion Sillimanite 6060" refractory tube made by Champion Porcelain Co.

of one German porcelain. They are listed in Table II, and two of them are shown in Fig. 6. It will readily be seen that, except for a slight displacement which is probably due to solid solution, the identity of these spectrograms with that of the standard mullite is complete. This is true also for the other two. The latter, however, contain corundum in addition and there are for that reason extra lines on the spectrograms.

(3) Isle of Mull Samples The third type of pattern was found by Bradley and Roussin to be given by two samples of natural mullite from the Isle of Mull, supplied to them by Dr. Thomas. These gave patterns that they considered closer to that of porzite than were the patterns of the materials described in group I.

One of Bradley and Roussin's natural mullites is from Nun's Pass, and Dr. Thomas supplied mullite from the same locality for the early work of Bowen, Greig, and Zies. Presumably the specimens were alike. This material, after treatment with acids to remove the matrix, contained a good deal of rutile. For this reason Bowen, Greig, and Zies[1b] did not analyze it but for this purpose selected a similar material, also supplied by Dr. Thomas, from a nearby location, Seabank Villa, which when purified by acid contained only a few plates of corundum. The indices of refraction of the Nun's Pass mullite were somewhat higher than those of the Seabank Villa mullite, a fact to be attributed to a slightly greater amount of iron and titanium in solid solution.

The reasons advanced by Bowen, Greig, and Zies, including microscopical, chemical, and thermal

studies, for supposing this natural material to be the same species as that which had been found in the study of equilibrium in the system Al_2O_3–SiO_2 have not been considered by Bradley and Roussin. They simply state that the patterns are different from those given by their other materials, and show the pattern without stating what differences they consider significant. They say, "the differences shown in this photograph can not be accounted for by the possible presence of any impurity, for the lines are not only different in number but in many cases quite distinct, both in intensity and in position." Solid solution of iron and titanium, although already pointed out by Bowen, Greig, and Zies, has not been considered as a possible cause of the differences in position. We suggest that this, together with the possible presence of rutile, may account for these differences of position. The most striking differences that we are able to discover in the reproduction of the photograph are, however, in intensities, and a comparison of the photograph reproduced in Fig. 5 of this paper with their photograph, Number 21, will show a marked similarity. The intensity changes found in spectrograms of mullite that had undergone a hydrofluoric acid treatment, and shown to be due to orientation, are to be seen clearly in this photograph. There is, then, no basis furnished by the photographs for distinguishing these crystals from those of either of the first two groups.

As already noted (page 570, Table I), we have taken X-ray powder photographs of the mullite from Nun's Pass and also of that from Seabank Villa. Both gave good mullite patterns with a slight displacement of the lines toward the origin. When mounted on a silk thread, after being removed from the matrix, both gave photographs showing the intensity changes due to orientation.

(4) Sillimanite The fourth pattern was given by natural sillimanite only. Consequently no comment is called for.

What differences are to be found between the patterns of the first two groups the authors are quite unable to discover from the reproductions, and they are not pointed out by Bradley and Roussin. We have therefore no suggestion to make, but we may well ask, in view of what we have already said, whether such differences as we have shown to be attributable to solid solution, with perhaps some effect due to orientation of crystals, may not explain their separation into two groups.

VI. Discussion of the Report by Krause and Wöhner on the Products Resulting from Heating Clays

The second paper that we were requested to comment on is by Krause and Wöhner[9] and is entitled "Über die Vorgänge beim Brennen technischer Kaoline." These authors have made an investigation of the effect of heating on seven different clays. We are concerned here with only one part of their work, that dealing with the nature of the aluminum silicate formed at high temperatures.

They found, by using X-ray powder photographs, that the aluminum silicate began to crystallize in the temperature range 900 to 960° and that the same material was formed at the higher temperatures. In only one

[9] O. Krause and H. Wöhner, *Ber. deut. keram. Ges.*, **13**, 485 (1932).

case was the highest temperature at which the clay was heated below 1600°. The diffraction patterns given by these crystals are said to correspond completely with that of sillimanite. In the discussion of this in the conclusion, however, they say—in apparent contradiction—that there are certain differences between the patterns given by these crystals and that of sillimanite. In one case they extracted the products of heat treatments at 960° and at 1270° with potassium hydroxide (no microscopic control is mentioned) and analyzed the residue which gave them a composition near that of sillimanite. This they considered a confirmation of their X-ray results.

They consider further that some experiments, not described in the paper, give reason to conclude that under all conditions sillimanite is more stable than mullite. The reason advanced is that sillimanite is very resistant to attack by HF while mullite gives up silica when treated in this way until a residue is left that has a corundum structure.[10] The rate of attack by HF of course tells nothing about their relative stability at high temperatures. Quite positive information on this point has been obtained by Bowen and Greig[1a] and by Greig[1c] which showed that sillimanite when heated to temperatures above 1550° was decomposed, giving mullite plus a siliceous liquid. No mention of this, however, is made by the authors. As to the corundum structure given by the residue, it may be noted that no mention is made of any microscopic control, and in its absence there is no reason to suppose that corundum may not have been present in the original material. The solution of the mullite would in that case simply concentrate the corundum so that its pattern would appear on the X-ray powder photograph.

In their discussion the authors state that the composition of the aluminum silicate in question can not be determined from their data.[11] They recognize, however, that analyses of crystals from ceramic ware have shown a greater alumina content than that indicated by the formula, $Al_2O_3 \cdot SiO_2$, and also that certain differences have been found between the diffraction patterns given by mullite and sillimanite. They then cite the explanation of Taylor and of Goldschmidt for the great similarity of these diffraction patterns: that aluminum atoms may take the place of silicon atoms in the crystal lattice with only a slight rearrangement of the oxygen atoms, and consider this a reason for assuming that the composition of these crystals is variable. Because of this they suggest that the word "keramite," a word originally suggested by Mellor and Scott, be used for such materials.

NOTE: Mellor and Scott (*Trans. Ceram. Soc.* [Eng.], **23**, 327–28 (1924)) examined kaolin and mixtures of kaolin and alumina heated at various temperatures between "1200° and 1700°," and "found that the insoluble residue left after treatment with hydrofluoric acid has the composition of sillimanite at the lower temperatures, but after heating to 1700° the composition tends to approximate to $3Al_2O_3 \cdot 2SiO_2$." Three analyses were given. Mellor and Scott concluded that there was some evidence for the

[10] "...dass dem Sillimanit unter allen Umständen eine grössere Stabilität zukommt als einem mullitisch zusammengesetzten Material (denn gerade der Sillimanit ist gegenüber der Flusssäurebehandlung sehr widerstandsfähig, während mullitisch und ähnlich zusammengesetzte Materialien hierbei Kieselsäure bis zum Verbleiben eines Korundgitters abgeben)...," from O. Krause and H. Wöhner, *loc. cit.*, p. 518.

[11] "Welche chemische Zusammensetzung dieses Aluminiumsilikat nun hat lässt sich nicht entscheiden," *ibid.*, p. 518.

existence of solid solution between the two compounds, $Al_2O_3 \cdot SiO_2$ and $3Al_2O_3 \cdot 2SiO_2$. They suggested the name "keramite" for the new compound, $3Al_2O_3 \cdot 2SiO_2$, which Bowen and Greig had just found in their equilibrium work on the system, Al_2O_3–SiO_2. While the paper by Mellor and Scott was in press, the paper giving it the name "mullite" was published.

So far as we are able to see, that part of the work of Krause and Wöhner that is discussed here has given no new information on this subject, and their results are too indefinite to be considered as either confirming earlier data or conflicting with it. Our own results on heating clays have been discussed on pp. 574 and 577, and may be referred to here.

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TESTS OF REINFORCED BRICK COLUMNS*

By Ingr Lyse

ABSTRACT

This paper presents the data obtained in an extensive investigation on reinforced brick columns. The results furnished a basis for the development of rational design formulas. The strengths of the columns were found to be made up of the effective strength of the masonry plus the yield-point strength of the longitudinal reinforcement. A study of the type of masonry mortars revealed the fact that Portland cement mortar containing 15% ordinary brick clay by weight of the cement gave better results than did any of the other types used.

A review of all known experiments on brick piers and columns is given.

I. Introduction

Numerous tests have been made in the past on the strength of plain brick piers and columns, but until recently no data were available on the advantage of reinforcement in brick columns. The introduction of reinforced brick construction into the field of structural engineering made it imperative to secure reliable data on the structural behavior of these columns. During the early part of 1933 the Fritz Engineering Laboratory of Lehigh University tested thirty-three columns, the results of which are presented in this paper. All columns were about $12^1/_2$ by $12^1/_2$ inches in cross-section and 10 feet in length. Five of the columns had no reinforcement, six had longitudinal steel only, nine had lateral reinforcement only, and thirteen had both longitudinal and lateral reinforcement. The brick used were of three types: common solid stiff-mud brick, de-aired solid brick, and de-aired perforated brick. All three types of brick were of good quality, the de-aired types being excellent. Five types of mortar were used: straight Portland cement mortar, cement mortar containing 15 and 100% lime by volume, and cement mortar containing 5% celite or 15% clay by weight of the cement.

II. Earlier Tests on Brick Columns

Tests of brick piers at the Watertown Arsenal in 1882 are reported in Kidder's Architects and Builders Pocket Book. The cross-section was 8 by 12 inches and the nominal height varied from $20^1/_2$ to 23 inches. "Common" lime mortar, 3 parts lime mortar and 1 part Portland cement, 3 parts lime mortar and 1 part natural cement, 1:2 Portland cement mortar, and 1:2 natural cement mortar were used. The compressive strength of the piers varied from 1562 to 3020 pounds per square inch or from 12.8 to 24.8% of the compressive strength of the brick.

Other tests made at the Watertown Arsenal are reported in several of the annual reports of Tests of Metals. Tests of twelve brick piers for the city of Philadelphia in 1883 are reported in the 1884 volume. The piers or cubes were 13 by 13 by 13 inches.

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* Received July 10, 1933.

Editor's Note: For papers on reinforced brick masonry published by the American Ceramic Society, see the following references:

E. E. Krauss and Judson Vogdes, "Method of testing reinforced brick masonry demonstration structures," *Jour. Amer. Ceram. Soc.*, **15** [5], 300–305 (1932); "Preliminary outline of program of research in reinforced masonry," *ibid.*, pp. 305–13; "Results of tests on 10 demonstrations of reinforced brick structures with summary covering tests on 13 structures," *ibid.*, pp. 273–300; "Tentative specifications for reinforced brick masonry," *ibid.*, pp. 313–20.

E. E. Krauss, Judson Vogdes, and J. R. Shank, "Results of tests on 7 demonstration structures with summary covering tests on 20 structures," *Bull. Amer. Ceram. Soc.*, **12** [6], 166–97 (1933).

Four kinds of brick and two kinds of mortar, 1:4 lime mortar and 1:2 natural cement mortar, were used. The compressive strength of the piers ranged from 10.7 to 26.3% of that of the brick. In the 1884 volume, results are also given for tests of 33 piers varying from 8 by 8 inches to 16 by 16 inches in cross-section and from 16 inches to 10 feet in length, using Portland cement mortar, natural cement mortar, and lime mortar. The compressive strength of these piers ranged from 6.1 to 27.2% of the compressive strength of the brick used. In the 1886 volume the results are given for fifty-three piers ranging in sizes from 8 by 8 inches to 16 by 16 inches in cross-section and from 2 to 12½ feet in length, using a natural cement mortar. The strengths of the columns ranged from 6.4 to 18.2% of the strength of the brick. The strength of the columns was found to be inversely proportional to the ratio between longitudinal and lateral dimension; for a ratio of 3 the column strength was 17% of the brick strength, and for a ratio of 15 the column strength was only 13% of the brick strength.

In the 1893 volume the results are given for six brick piers varying from 8 by 8 to 16 by 16 inches in cross-section and from 6 to 8 feet in height. Lime mortar and neat Portland cement paste were used in solid and hollow piers with the brick on edge and flat. The compressive strength of the piers ranged from 601 to 4623 pounds per square inch. In the 1904 volume of Tests of Metals tests of twenty-six brick columns, 12 by 12 inches and 8 feet long, are reported. The mortars used were neat Portland cement paste, 1:2 and 1:3 cement mortar, and 1:3 lime mortar. The columns having neat cement paste had an average strength equal to 30% of the strength of the brick; for 1:3 Portland cement mortar the average strength was 24% and for 1:3 lime mortar the column strength was only 13% of the strength of the brick. In the 1905 volume, a report is given of 13 columns having clay brick and one column having sand-lime brick. These columns were 12 by 12 inches by 8 feet with solid or hollow cores in neat Portland cement mortar, 1:2, 1:3, and 1:5 cement mortars, and 1:3 lime mortar. The columns having neat cement mortar gave strengths from 1500 pounds per square inch for sand-lime brick to 4550 pounds per square inch for clay brick. Columns having 1:3 lime mortar gave strengths between 652 and 955 pounds per square inch. The 1906 volume contains a report of tests of 15 brick piers, 12 by 12 inches by 8 or 9 feet. Neat Portland cement paste, 1:1, 1:3, 1:5, and 1:6 Portland cement mortars, and 1:3 lime mortar and 1:1:1 and 1:1:3 cement-lime mortars were used. The strengths of the clay brick columns varied from 850 to 3440 pounds per square inch, and that of the sand-lime brick columns from 450 to 1400 pounds per square inch. In the 1907 volume of Tests of Metals results are given for thirty-two columns about 12 by 12 inches by 8 feet long. The mortars were neat Portland cement paste, 1:1, 1:2, and 1:3 Portland cement mortar, and 1:3 lime mortar. The strength of the columns was found to be closely related to the strength of the mortar used. The strength increased considerably with the increase in age of the column, in one case varying from 2100 pounds per square inch at four hours to 4500 pounds per square inch at seven days for neat cement paste.

In the *Transactions of the Association of Civil Engineers of Cornell University* for 1897 to 1898 and 1899 to 1900, results are given for tests of brick columns made at Cornell University. One group of tests consisted of eighteen piers, 13 by 13 inches, varying from 2½ to 7½ feet in length, with 1:2 Portland cement mortar. The strength of the piers varied between 635 and 1093 pounds per square inch, or between 17 and 31% of the brick strength. Another group consisted of fourteen piers, eleven of which had horizontal reinforcement consisting either of iron straps, wire netting, or iron plates. The piers were 13 by 13 inches and 6¾ feet long, with 1:2 Portland cement mortar. The results showed that the average column strength in percentage of brick strength was 30 for the plain brick columns, 24 when iron straps were used in every fourth course, 22 in every sixth course, and 24% in every eighth course. For wire netting the percentage was 46 for netting in every course and 33 for netting in every second course. For iron plates in every fourth course the percentage was 28.

At the University of Toronto seventeen brick piers were tested.[1] The piers were 9 by 9 inches in cross-section and varied in length from 16 to 72 inches. The mortars used were 1:2 lime mortar and 1:3 Portland cement mortar. The columns having lime mortar gave strength averaging 17% of the brick strength, and the columns having Portland cement mortar averaged 42% of the brick strength.

At Purdue University tests were made in 1906–1907 on thirty-two short columns of clay and sand-lime brick.[2] A 1:3½ lime mortar was used for all piers which had a

[1] A report of this test is given in *Digest of Physical Tests*, Vol. 1, No. 3, 1896.
[2] A report of the results is given in *Engineering News*, February 25, 1909.

cross-sectional area of 12 by 12 inches and a height of 4 feet. The compressive strength of these piers ranged from 7.3 to 35% of the strength of the brick.

Bulletin No. 27 of the University of Illinois (1908) contains a detailed report on tests of sixteen brick columns and sixteen terra cotta columns. The brick columns were $12^1/_2$ by $12^1/_2$ inches in cross-section and 10 feet in length. Two grades of brick were used, an excellent building brick and a soft grade brick. The best grade brick averaged 10,700 pounds per square inch in strength and the soft brick averaged only 3900 pounds per square inch. Eleven of the brick columns had 1:3 Portland cement mortar, two had 1:5 Portland cement mortar, one had 1:3 natural cement mortar, and two had 1:2 lime mortar. The percentage of the average strength of the column to that of the brick at an age of about two months was 31 for well-laid 1:3 Portland cement mortar, 27 for poorly laid 1:3 Portland cement mortar, 21 for well-laid 1:5 Portland cement mortar, 16 for well-laid natural cement mortar, and 14 for well-laid 1:2 lime mortar when first-class brick were used. For soft brick columns the average percentage was 27 for well-laid 1:3 Portland cement mortar. The initial modulus of elasticity varied from about 4,000,000 to 5,500,000 pounds per square inch for first-class brick columns in well-laid 1:3 Portland cement mortar, between 3,000,000 and 3,500,000 pounds per square inch for well-laid 1:5 Portland cement mortar, 800,000 pounds per square inch for 1:3 natural cement mortar, and varied between 101,000 and 107,000 pounds per square inch for 1:2 lime mortar. For soft brick columns the initial modulus of elasticity was about 430,000 pounds per square inch for 1:3 Portland cement mortar.

Tests[3] were made of two large brick piers 48 by 48 inches in cross-section and 12 feet in height. The mortars used were 1:1 Portland cement and 1:1 lime. The pier having cement mortar gave compressive strength equal to 28.9% and that having lime mortar 7.5% of the strength of the brick.

At Columbia University tests were made in 1914 and 1915 on sixty-nine brick piers. The piers were 8 by 8 inches in cross-section by 7 feet in height. The mortars used were 1:3 Portland cement with no admixture, with 10, 15, 25, 50, and 75 % lime as admixture, and 1:3 lime mortar. The age at test varied from seven days to three months. Two types of brick were used with compressive strengths of 10,500 and 3221 pounds per square inch. With straight 1:3 cement mortar the strength of the piers increased slightly between the ages of 7 and 28 days, but showed no increase between 28 days and 3 months. When lime admixture or lime mortar was used the strength of the piers increased consistently up to the age of three months. The test results indicated that the highest strength was obtained by the use of cement mortar containing 25% lime. The compressive strength of the piers ranged from 14.6 to 52.1% of the strength of the brick.[4]

Tests were made of fifty brick piers at the Bureau of Standards Laboratory at Pittsburgh, Pennsylvania.[5] The piers were 30 by 30 inches in cross-section and either 5 or 10 feet long. Different grades of brick were used with 1:3 Portland cement mortar without admixture and with 15% lime, and 1:3 and 1:6 lime mortars. One of the piers had wire mesh in every joint and another one had wire mesh in every fourth joint. The compressive strength of the plain brick columns ranged from 7.6 to 75.1% of the strength of the brick. The wire mesh in every joint raised the percentage to 92.7.

Tests were made of fourteen brick piers at the University of Toronto.[6] The piers were 8 by 8 inches in cross-section and varied from 1 to 9 feet in height. The mortars were 1:3 Portland cement mortar with 15% lime and 1:3 lime mortar. The brick had a strength of only 1000 pounds per square inch flat. The piers with cement mortar gave strength varying from 54 to 78% of the brick strength, while the piers with lime mortar gave values between 30 and 55%. The short piers gave higher strength than did the long piers.

A report is given[7] of tests of four brick piers cut from masonry of wrecked buildings, 16 years old. The piers were 12 by 16 inches in cross-section and varied in height from $21^1/_2$ to 27 inches. A 1:3 Portland cement mortar was used in the piers. The compressive strength of the piers varied from 877 pounds per square inch for a pier with uneven bearing plate to 2093 pounds per square inch.

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[3] *Eng. Rec.*, March 22, 1913.

[4] A report on these tests is given in *Bulletin J* of the Hydrated Lime Bureau of the National Lime Association, June 1, 1916.

[5] Reported in Bur. Stand., *Tech. Paper* No. 111.

[6] Reported in Proceedings of the Fifth Annual Meeting of the Building Officials Conference, 1919.

[7] *Eng. News-Rec.*, August 31, 1932.

TABLE I

SUMMARY OF TESTS ON BRICK PIERS AND COLUMNS

Column reference No.	Year	No. of columns	Nominal height from (in.)	Nominal height to (in.)	Nominal lateral dimensions from (in.)	Nominal lateral dimensions to (in.)	Mortar	Strength of masonry from (lb./sq. in.)	Strength of masonry to (lb./sq. in.)	Strength ratio masonry to brick from (%)	Strength ratio masonry to brick to (%)	Approximate age (months)
1	1882	8	20½	23	8 × 12		Various	1562	3020	12.8	24.8	5
2	1883	6	16		12 × 12		1 N.C.–2S	1021	2021	Not given		22
3	1883	12	13		13 × 13		Various	699	2685	10.7	26.3	15
4	1884	33	16	120	8 × 8	16 × 16	Various	773	3776	6.1	27.2	15 –24
5	1886–1891	53	24	150	8 × 8	16 × 16	Mostly 1 N.C.–2S	964	2798	6.4	18.2	21
6	1893	6	72	96	8 × 8	16 × 16	Various	601	4623	Not given		2½
7	1895–96	17	16	72	9 × 9		Various	296	2408	10.7	60.9	2½
8	1895–97	57	72		13 × 13	18 × 28	Various	145	1940	7.8	46.8	3 –11
9	1897–98	18	30	78	13 × 13		1 P.C.–2S	635	1093	16.9	31.1	3½–15
10	1898–99	14	80		13 × 13		1 P.C.–2S	780	1692	22.2	48.0	7
11	1904	26	96		12 × 12		Various	465	4700	8.8	41.5	1 – 6
12	1905	14	96		12 × 12	12½ × 12½	Various	652	4552	7.4	50.0	2½– 6
13	1906	15	96		12 × 12	12½ × 12½	Various	450	3437	11.2	40.3	3½– 8½
14	1906–07	32	48		12 × 12		1 L–3½S	178	594	7.3	35.0	1½–15½
15	1907	32	96		12 × 12		Various	730	5608	Not given		24
16	1907	16	120		12 × 12		Various	1030	4110	12.7	38.4	2 – 6
17	1913	2	144		48 × 48		Various	757	2917	7.5	28.9	1
18	1914–15	69	84		8 × 8		Various	1032	4435	14.6	52.1	½– 3
19	1915	50	60	120	30 × 30		Various	126	3800	7.6	75.1	1 – 4
20	1915	57	5	79	9 × 9	11 × 11	Various	371	2340	10.2	71.8	1
21	1918	14	12	108	8 × 8		Various	300	780	30.0	78.0	3½
22	1919	4	22	27	12 × 16		1 P.C.–3S	877	2093	Not given		192
23	1920–21	131	42	84	12 × 12		1 P.C.–3S	495	2656	17.6	99.0	1 – 3

NOTE: Column reference Nos. 1, 2, 3, 4, 5, 6, 11, 12, 13, and 15, tested at Watertown Arsenal. Nos. 7 and 20, tested at the University of Toronto. No. 8, tested in England. No. 16, tested at the University of Illinois. No. 18, 22, 23, tested at Columbia University. Nos. 9 and 10, tested at Cornell University. No. 14, tested at Purdue University. Nos. 17 and 19, tested at Bureau of Standards. No. 20, tested at Swedish Technical Institute.

At Columbia University tests were made of 131 brick piers.[8] The piers were 12 by 12 inches in cross-section with a height of either $3^1/_2$ or 7 feet with 1:3 Portland cement mortar. Clay brick, sand-lime brick, and concrete brick were used in the piers. The compressive strength of the piers ranged from 17.6 to 99.0% of the strength of the brick.

Tests of fifty-seven brick piers were made in England[9] in 1895 to 1897. The piers varied in cross-section from 13 by 13 inches to 18 by 28 inches and were 6 feet in height. Different grades of brick were used with 1:4 Portland cement mortar and with 1:2 lime mortar. The compressive strength of the piers varied from 7.8 to 46.8% of the strength of the brick.

A report was made on tests of fifty-seven brick piers at the Swedish Technical Institute.[10] The piers varied in cross-section from 8 by 8 inches to 11 by 11 inches and in height from 5 inches to 9 feet. The mortar used was either 1:3 lime mortar or a mixture of cement and lime in the following proportions: 1 cement, 2 lime, 9 sand; 1 cement, 1 lime, 6 sand; 2 cement, 1 lime, 9 sand; 1 cement, 2 lime, 7 sand; and a 1:3 Portland cement mortar. Some of the piers were eccentrically loaded. The results showed that the shorter the pier the greater was the strength. They also showed that the eccentricity of loading decreased the strength materially. The 1:3 cement mortar gave higher strength than did any of the other mortars. The compressive strength of the piers ranged from a minimum of 10.2% for piers loaded at the quarter point to a maximum of 71.8% for concentrically loaded piers.

A summary of the tests of brick piers is presented in Table I.

III. Materials

The brick used in this investigation[11] were of three types, solid brick made by the stiff-mud process, solid de-aired brick, and perforated de-aired brick. The de-aired brick gave excellent strength results, the average strength for solid brick for one group being 13,760, 10,070, and 10,680 pounds per square inch for flat, on end, and on edge, respectively; and for another group 11,000 pounds per square inch flat. One group of perforated brick had a strength of 12,190, 6760, and 7720 pounds per square inch, and another group 7520, 4840, and 5080 pounds per square inch for flat, on end, and on edge, respectively. The brick of the old stiff-mud type gave an average compressive strength of 8000 pounds per square inch flat, 3780 pounds per square inch on end, and 7670 pounds per square inch on edge. The rate of absorption for the three types of brick used is shown in Fig. 1. The perforated brick showed absorption about twice that of the solid brick for less than ten minutes of submersion. The solid stiff-mud brick showed a higher absorption than did the solid de-aired brick. The difference in structure of the de-aired brick and the stiff-mud brick is shown in Fig. 2 for brick sawed into sections. It is noted that the stiff-mud brick had laminations and small shrinkage cracks, while the de-aired brick showed a very dense and uniform structure.

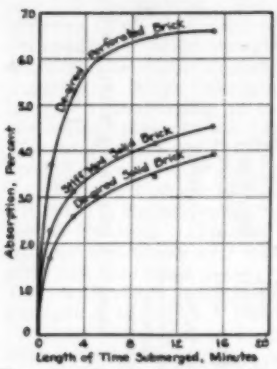

FIG. 1.—Rate of absorption for brick.

The average weight of the solid stiff-mud brick was 2116 grams per

[8] Department of Civil Engineering Testing Laboratories, Columbia University, *Bull.* No. 2, 1923.

[9] Reported in Royal Institute of British Architects, Report on Brickwork Tests, 1905.

[10] *Tonind.-Ztg.*, Sept. 9 and 21, 1916.

[11] The brick were manufactured by the Lehigh Brick Works at Allentown, Pa.

brick, the solid de-aired brick 2264 grams, and the perforated de-aired brick 2000 grams.

The cement used for the mortar in the investigation was standard Portland cement manufactured by the Lehigh Portland Cement Company.

FIG. 2.—Structure of brick: top, stiff-mud brick; bottom, de-aired brick.

The mortar sand was a New Jersey lake sand having a sieve analysis as follows:

Per cent retained on sieve No.					Fineness modulus
100	48	28	14	8	
85.3%	55.3%	30.1%	12.6%	3.4%	1.87%

This sand proved to be very satisfactory and was used throughout the investigation.

Three different admixtures were used in the mortar. In one group of columns hydrated lime in amounts equal to 15 and 100% by volume of the cement was used. The mortar which contained 100% lime had six parts sand to one part cement. All other mortars had three parts sand to one part cement by loose volume, except the mortar for the last five columns which had two parts sand by weight to one part cement. One

sack of cement (1 cubic foot) was taken as weighing 94 pounds, and one sack (1 cubic foot) hydrated lime as 50 pounds. In another group of columns 5% celite by weight was used as an admixture to the cement mortar in order to provide for the necessary plasticity. A third group had 15% by weight of ordinary brick clay added to the mortar. The sieve analysis of the brick clay was as follows:

Per cent retained on sieve No.					
200	100	48	28	14	8
84.6%	77.0%	66.4%	50.4%	27.7%	5.3%

The 1:3 cement mortar which contained no admixture lacked plasticity and was considered unpractical for ordinary masonry. The addition of

TABLE II

RESULTS OF BRICK COLUMN TESTS

Mortar mix	Admixture in mortar (%)	Reinforcement (%) Longitudinal	Reinforcement (%) Lateral	Maximum load (lb.)	Maximum strength (lb./sq. in.)	Type of brick (de-aired)
1:3	15 lime	0	0	738,000*	4730*	Solid
1:3	15 "	0	0	800,000	5130	Solid
1:6	100 "	0	0	410,500	2630	Perf.
1:3	15 "	2.0	0	800,000*	5130*	Solid
1:3	15 "	2.0	0	810,000	5200	Solid
1:3	15 "	2.0	0	708,700	4540	Perf.
1:6	100 "	2.0	0	628,200	4020	Solid
1:6	100 "	2.0	0	473,500	3030	Perf.
1:3	15 "	2.0	1/4" ties[c]	800,000*	5130*	Solid
1:3	15 "	2.0	1/4" ties[c]	752,000	4820	Solid
1:3	15 "	2.0	1/4" ties[c]	732,500	4700	Perf.
1:6	100 "	2.0	1/4" ties[c]	483,400*	3100*	Solid
1:6	100 "	2.0	1/4" ties[c]	584,200*	3740*	Solid
1:6	100 "	2.0	1/4" ties[c]	671,000	4300	Solid
1:6	100 "	2.0	1/4" ties[c]	527,700	3380	Perf.
1:3	0	0.67	3/8" ties[a]	530,000	3400	Perf.
1:3	0	0.67	3/8" ties[b]	452,800	2900	Perf.
1:3	0	0	1/4" ties[b]	479,300	3070	Perf.
1:3	15 clay	0	1/4" ties[b]	594,300	3800	Perf.
1:3	5 celite	0	1/4" ties[b]	531,000	3400	Perf.
1:3	5 "	0	1/4" ties[b]	705,000	4520	Perf.
1:3	5 "	0	1/4" ties[b]	562,000	3600	Solid†
1:3	5 "	0	1/4" ties[b]	640,500	4100	**
1:3	15 clay	0	0	657,800	4220	Perf.
1:3	15 "	0.67 H.Y.	1/4" ties[b]	800,000	5130	Perf.
1:3	15 "	0	1/4" ties[b]	489,200	3140	Perf.
1:3	15 "	0	1/4" ties[d]	598,600	3830	Perf.
1:3	15 "	0	1/4" ties[a]	609,200	3900	Perf.
1:2	15 "	0	0	636,000*	4080*	Solid
1:2	15 "	0.67 H.Y.	0	690,000*	4420*	Solid
1:2	15 "	0.67 H.Y.	1/4" ties[c]	800,000*	5130*	Solid
1:2	15 "	0.67 H.Y.	Flats[c]	659,000*	4220*	Solid
1:2	15 "	0.67	1/4" ties[c]	715,000*	4580*	Solid

* Tested at the age of 7 days, all others tested at 28 days.
† Underfired, low-strength brick.
** Solid stiff-mud brick.
a, b, c, d, reinforcement in every 1st, 2nd, 3rd, and 4th joint, respectively.

15% hydrated lime improved the plasticity somewhat but did not produce the necessary workability. The 5% celite improved the workability of the mortar but did not produce the plasticity obtained by 100% hydrated lime or 15% clay. Every indication pointed toward the mortar

containing 15% clay as the more desirable one. It had the plasticity of the 100% hydrated lime mortar and had strength nearly equal to that of the straight Portland cement mortar. The results of the compressive strength at 28 days of 3- by 6-inch mortar specimens made from different batches of mortar gave average values of 2790, 1420, 2290, and 2370 pounds per square inch for straight cement mortar, mortar containing 100% lime, 5% celite, and 15% clay, respectively.

The longitudinal reinforcement consisted of four bars with milled ends bearing directly against the end plates of the columns. The physical properties of the longitudinal reinforcement were as follows:

		Tensile strength (lb. per sq. in.) (yield point)	(ult.)	Elongation in 10 in. (%)
1 in. diam.	Intermediate	43,600	83,000	20.3
1/2 in. square	High strength	60,000	92,500	22.2
1/2 in. square	High strength	94,500	132,500	6.0

The lateral reinforcement consisted of soft steel ties of either 3/8 or 1/4 inch diameter placed in different mortar joints. The ties were bent into 8-inch square sections with at least 5-inch laps. One column had wall strips for lateral reinforcement. Table II gives the information for the columns used in this investigation.

IV. Construction and Storage of Columns

The reinforced brick columns were constructed by brick masons in the employ of a contractor in Allentown. Generally a column was completed in one day. Occasionally, however, a column was one-half completed on one day and finished on the next day. The lateral ties were pressed into the mortar in the joints where they were used. The thickness of the mortar joints was approximately 1/2 inch. The longitudinal reinforcement was lined up on the base plate before the construction of the column began, the brick followed the alignment of the steel, and the last layer of brick was slightly below the top of the steel. After the columns were completed they were capped with a 1:1 cement mortar. The capping plate was pressed down so as to bear against the milled ends of the longitudinal reinforcing steel.

The columns were stored on the main floor of the laboratory. During the first seven days the columns were sprinkled with water once in the morning and once in the afternoon. The last five columns, however, were sprinkled with water only at the age of one day.

V. Methods of Testing

A few of the columns were tested at the age of 7 days while the majority were tested at the age of 28 days. The columns were placed in the testing machine with both base and top plates attached to the columns. The base of the column rested directly on the table of the testing machine, and on the top of the column the load was transferred from the movable head of the machine to the column by means of a spherical bearing block. The load was applied in increments of either 25,000, 50,000, or 100,000 pounds. A complete set of deformation observations was taken after each increment of loading. The deformation instruments were removed when the columns had been loaded to approximately two-thirds of their

strength, and further load was applied gradually until the ultimate strength was reached.

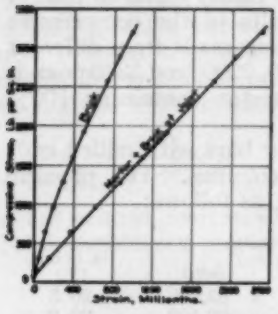

FIG. 3.—Deformation diagram for brick and for mortar joint.

VI. Deformations

The longitudinal deformations were observed at each increment of loading by means of $^1/_{1000}$-inch Ames dials working on a gage line of about nine feet. The dials were clamped to a collar which was attached to the column about 6 inches from the bottom. Steel bars ($^1/_2$ inch square) were clamped to a collar which was attached to the column at about 6 inches from the top of the column. These bars bore against the plunger of the dials which were attached to the collar near the base of the column. The total movement of the two collars was registered by the dials. Lateral deformation measurements were taken on some of the columns by means of $^1/_{10,000}$-inch Ames dials. These dials were so attached to steel frames

FIG. 4.—Failure of columns having no lateral reinforcement.

FIG. 5.—Failure of columns having $^1/_4$-inch diameter lateral ties.

as to give the deformation in a gage length of about 11 inches. Lateral deflection measurements were taken on the first group of columns, but due to the smallness of the deflection these measurements were abandoned.

Two of the columns had Huggenberger tensometers attached to the brick and also across the mortar joint. These instruments gave the relative deformation of the brick and the joint and also furnished data from which to compute the modulus of elasticity of the brick. The stress-strain curve for the brick and for the joint is shown in Fig. 3. It is noted that the initial modulus of elasticity of the brick was about 5,000,000 pounds per square inch.

FIG. 6.—Failure of columns having $^3/_8$-inch diameter lateral ties.

VII. Types of Failure

Three distinct types of failure occurred. The columns which had no reinforcement collapsed completely upon reaching the maximum load. The columns with longitudinal but no lateral reinforcement showed vertical splitting. When the load approached the maximum, sounds of cracking were heard and vertical cracks were seen to follow the vertical mortar joints and straight through the brick between these joints. Thus long vertical cracks occurred and at maximum load the column failed in sections as is indicated in the photograph shown in Fig. 4. The columns which had both longitudinal and lateral reinforcement showed local failure without collapsing. For small amounts of lateral reinforcement the cracks followed the vertical joints as for columns without lateral ties. Figure 5 shows a typical failure of a column with both longitudinal and lateral ties. With large amounts of lateral reinforcement, however, the splitting action took place at the layer of the ties, and the brick spalled off outside the ties causing failure by buckling as shown in Fig. 6.

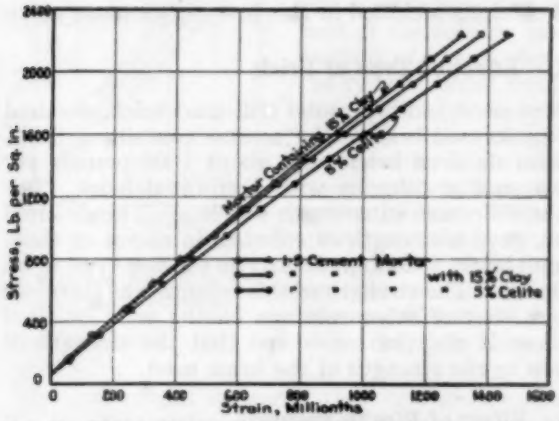

FIG. 7.—Effect of type of mortar on elastic properties of perforated brick columns.

VIII. Type of Mortar

The type of mortar used for reinforced brick columns had a marked effect upon their strength. Columns 18, 19, and 20 were identical except for the type of mortar used. The masons were strongly in favor of the

mortar containing 15% clay. This mortar stuck to the trowel and could be worked better than any of the other mortars included in the investigation. From a workability standpoint the mortar containing 100% lime was the second choice of the masons. However, the high lime content reduced the strength of the mortar to such an extent as to eliminate this type where high strength was required. The 5% celite gave a fairly plastic mortar but could not compete with the 15% clay and the 100% lime mortar. Mortar containing 15% lime was difficult to handle and so was the straight cement mortar to a still greater extent. The strength of the column containing mortar with 15% clay was greater than for a straight cement mortar and for a mortar containing 5% celite. No doubt the better workability gave a more compact joint and therefore contributed to the strength. In general the stronger the mortar used, the stronger was the column. For these columns the cement mortar containing 15% ordinary clay was by far the most satisfactory mortar. The stress-strain diagram for columns having straight cement mortar, 15% clay admixture, and 5% celite admixture, is given in Fig. 7. Perforated de-aired brick was used in these columns. The combined effect of the type of mortar and type of brick on the modulus of elasticity of the column is shown in Fig. 8. The results of tests on the 33 columns included in this investigation are given in Table II.

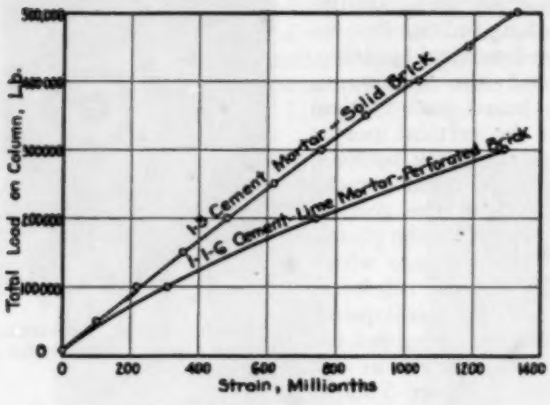

FIG. 8.—Deformation of plain brick columns.

IX. Effect of Type of Brick

Three types of brick were used, old-type solid stiff-mud brick, de-aired solid brick, and de-aired perforated brick. For mortar containing 100% lime the columns with solid de-aired brick were about 1000 pounds per square inch stronger than similar columns with perforated brick. For straight cement mortar the difference in strength was less. The de-aired perforated brick, however, gave a strength of columns in excess of those with ordinary solid stiff-mud brick. Column 22 had an inferior type of an underfired solid de-aired brick. The strength of this column was therefore correspondingly lower than that of other columns having solid de-aired brick. For given conditions it may be considered that the strength of the column is in proportion to the strength of the brick used.

X. Effect of Workmanship

The workmanship of the masons affected the strength of the columns. While this workmanship varied considerably, a variation in strength as

great as 100,000 pounds (or 600 to 700 pounds per square inch) may be attributed to this cause. The variation was naturally different for the different types of mortar used, but in general the mason who built the stronger columns with one type of mortar would also do so with another type of mortar.

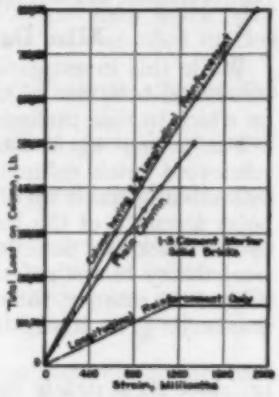

FIG. 9.—Effect of longitudinal reinforcement on deformation of column.

XI. Effect of Reinforcement

The longitudinal reinforcement contributed both to the rigidity and the strength of the columns. In general, the larger reinforcing bars did not contribute their full yield-point strength nor did they contribute their full elastic rigidity as seen from Fig. 9. This is probably due to the difficulty of producing as good a center portion of the column with the large bars in place as with smaller or no bars. The small bars ($1/2$ inch square) contributed their full elastic rigidity and also added their full yield-point value to the strength of the column. Figure 10 shows a load-deformation diagram for a column with small vertical bars. In the design of reinforced brick columns account may therefore be taken of the full yield-point value of the longitudinal reinforcement, provided the bars are small and sufficient lateral reinforcement is used.

While the lateral ties did not seem to contribute directly to the strength of the columns, they influenced the type of failure materially. Figures 4 and 5 show the type of failures of reinforced brick columns with and without lateral ties. For columns with no lateral ties the vertical fracture completely disrupted the column, while for the columns with sufficient lateral ties the failure was localized and the main part of the column remained unbroken. The amount of lateral ties did not seem to affect the type of break until too large diameter ties were used. For $3/8$-inch diameter ties in every or every other joint, the type of failure was of the nature illustrated in Fig. 6. Instead of cracking along the vertical joints and straight across the brick in line with the joints, these columns cracked in line with the location of the ties. The brick broke off in line with the ties and the columns failed in a typical buckling fashion. The increase in thickness of the joints with the heavier ties probably tended to decrease the strength of the columns.

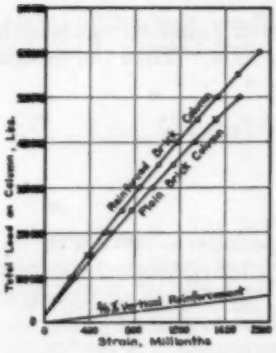

FIG. 10.—Load deformation diagram for plain and reinforced brick columns.

The test results indicated that $1/4$-inch diameter ties in every fourth joint would be sufficient as lateral reinforcement for the $12\,1/2$-inch square columns used in this investigation. The diameter of the lateral reinforcement should be $1/2$ or less of the thickness of the mortar joint. Welded

ties did not give as high a strength as lapped ties. The excess thickness of the ties due to the welding probably caused local failures before the full strength of the column was reached. Ordinary wall strips used as lateral reinforcement did not have any effect upon the behavior of the column.

XII. Design of Reinforced Brick Columns

While this investigation did not cover all the features involved in the structural behavior of reinforced brick columns, it furnished information on which to base preliminary design formulas.

For proper workmanship under rigid inspection the strength of the reinforced brick column having sufficient lateral reinforcement may be estimated as made up of the effective strength of the brick plus the yield-point strength of the longitudinal reinforcement. The effective strength of the brick is a function of the strength of the brick, the strength and workability of the mortar, the proportions of the column, the workmanship of the masons, the thickness of the mortar joint, and the curing of the masonry. The strength formula may therefore be expressed as

$$S = A_b f'_b k + A_s f_s \tag{1}$$

or (since A_b is nearly equal to A)

$$S = A(k f'_b + p f_s) \tag{2}$$

where S = total strength of column
A = total area of column
A_b = area of brick masonry
A_s = area of longitudinal steel
f'_b = ultimate strength of brick
f_s = yield-point stress of longitudinal steel
p = ratio between area of longitudinal steel and of column
k = effectiveness ratio of brick masonry, *i.e.*, ratio between strength of masonry and strength of brick used

The permissible working load may be considered equal to one-fourth of the ultimate load, or the factor of safety equal to 4. Thus the design working load would be equal to

$$P_b = A \cdot f_b = \frac{S}{4} = \frac{k}{4} A_b f'_b + \frac{f_s}{4} \cdot A_s = \frac{A}{4}(k f'_b + p f_s) \tag{3}$$

or the working stress

$$f_b = \frac{1}{4}(k f'_b + p f_s) \tag{4}$$

A factor of safety of 4 is considered ample, especially so in view of the fact that the factor of safety on ultimate strength for reinforced concrete columns proposed by the column committee of the American Concrete Institute is as low as $2^1/_2$ for fast loading and 2.0 for sustained load.

The value of k should be determined from experiments. A convenient method for determining k would be to make tests on small plain brick columns containing the proper type of brick and mortar, and the same workmanship and other conditions as that to be used in the structure. With k equal to 0.30, brick of 12,000 pounds per square inch compressive strength and 1% longitudinal steel of 60,000 lb. per sq. in. yield-point stress, the working stress would be

$$f_b = \frac{1}{4}(0.30 \times 12{,}000 + 0.01 \times 60{,}000)$$

$$= \frac{1}{4}(3600 + 600) \text{ or } 1050 \text{ lb. per sq. in.}$$

XIII. Summary

The most important results obtained in this investigation may be summarized as follows:

(1) Portland cement mortar containing 15% common brick clay as an admixture gave better results than any other mortar used in this investigation.

(2) Both the plasticity and the strength of the mortar affected the strength of the column.

(3) The strength of the brick had a marked effect upon the strength of the column.

(4) Columns with no lateral reinforcement collapsed completely upon reaching the maximum load.

(5) The lateral reinforcement had little if any direct effect upon the strength of the column, but generally determined the type of failure.

(6) Lateral ties $^1/_4$-inch diameter in every fourth joint gave sufficient lateral reinforcement for developing the yield-point strength of the longitudinal reinforcement.

(7) With sufficient lateral ties, small longitudinal reinforcing bars added their full yield-point strength to the strength of the column. Large reinforcing bars added only a portion of their yield-point strength.

(8) The workmanship of the mason had a marked effect upon the strength of the column.

(9) Reinforced brick columns having sufficient lateral reinforcement gave ample warning of impending failure.

(10) The strength of a properly reinforced brick column may be computed from the formula

$$S = A(k \cdot f'_b + p \cdot f_s)$$

(11) The safe working stress for properly reinforced brick columns may be computed from the formula:

$$f_b = \frac{1}{F}(k \cdot f'_b + p \cdot f_s)$$

or for a factor of safety of 4

$$f_b = \frac{1}{4}(k \cdot f'_b + p \cdot f_s)$$

Acknowledgment The investigation of reinforced brick columns was undertaken at the initiative of Judson Vogdes, representative of the National Brick Manufacturers Research Foundation. The Lehigh Brick Works of Allentown, Pennsylvania, through Robert K. Mosser, supplied all materials and built the columns. The testing of the columns was done as part of the research experiments of the Fritz Engineering Laboratory of Lehigh University.

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AN X-RAY STUDY OF THE TOUGHNESS OF PAVING BRICK*

By Guy E. Stong

ABSTRACT

X-ray diffraction photographs of paving brick were compared with those of pure materials.

The most important result obtained in this work is the discovery of a line in the X-ray diffraction pattern of paving brick which is characteristic of high-grade shale paving brick. This line, produced by an undetermined crystal, is more intense in the tougher than in the weaker brick. The line falls at 2.03 ± 0.01 Ångström units.

A further result of this investigation is the proof that cristobalite, mullite, sillimanite, alumina, and cyanite are not present in the paving brick studied. This also shows that mullite is not produced in ceramic materials at the relatively low temperature at which paving brick are fired.

I. Introduction

The most prominent characteristic of paving brick is their toughness or their resistance to impact and abrasion. Their toughness as determined by rattler loss is a property capable of accurate determination and thus comparisons may be made between brick with respect to this property.

It was thought that the toughness of a brick might be produced by the presence or the formation of some crystal within it. A study was therefore made of the crystalline structure of paving brick by means of X-rays.

The object of the present work was to find a correlation between the rattler loss of paving brick and the crystals present in them. X-ray powder photographs were taken of several paving brick and of quartz, alumina, mullite, sillimanite, and cyanite, the last three of which might be expected to give fibrous structure and hence strength. A comparison was made between the diffraction patterns produced by the pure substances and those produced by the paving brick.

Time did not allow the preparation of more standards, their comparison with the brick, or a petrographic examination.

II. Apparatus

The apparatus used was that produced by the General Electric Company for the production of diffraction patterns of materials by the Hull powder method. A Coolidge X-ray tube having a molybdenum target was used. The cassettes of 8-inch radius were equipped with zirconia filters so that the effective radiation had a wave-length of 0.712 Ångström unit. This equipment when operating under 15 milliamperes at 30,000 volts produced satisfactory exposures in 20 hours.

A special scale supplied with the apparatus was used to measure the spacing of the lines. This scale is designed to give direct readings of the interplanar distance in the crystal lattice for the various lines in Ångström units in accordance with the equation

$$\frac{d}{n} = \frac{\lambda}{2 \sin \theta}.$$

The scale, which was appended to the photographs taken, was adapted from this special scale and was reduced in the same proportion as the diffraction patterns.

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* Received June 19, 1933.

III. Paving Brick Samples

Brick Nos. 1, 2, and 3 were not paving brick and hence no rattler tests were made. The brick were made from Iowa clays and were fired to cone 8, the heat treatment thus being comparable with that of the average paving brick. They were included as a check.

Brick Nos. 4, 5, 6, and 7 were samples of shale brick for paving and were supplied by well-known American paving brick plants.

Brick Nos. 8, 9, 10, 11, 13, and 14 were laboratory samples obtained from a group of paving brick made by D. A. Moulton[1] in the course of research on the use of Iowa clays in paving brick.

Brick No. 12 was a high-grade brick made from No. 2 fire clay and was supplied by a well-known American paving brick plant.

IV. Standard Substances

The quartz was a pure colorless transparent crystal. In addition, specimens of sillimanite, mullite, alumina, and cyanite were X-rayed.

A. E. R. Westman[2] has given data (which were used in these studies) on cristobalite obtained by the Hull method and expressed in terms of the same scale as that used in this work.

V. The Standards Compared with the Brick Samples

Comparison of the quartz with the brick photographs showed that quartz is present in every brick in large amount. The position of a prominent quartz line was therefore calculated from crystallographic data[3] giving $d/n = 1.379$ Ångström units. This line was then used as the reference line in measuring the brick and quartz photographs. In the case of sillimanite the spacing as measured and as calculated from crystallographic data[4] checked closely.

Quartz is present since almost every quartz line checked a line in the brick photographs. Further, quartz is present in all of the brick in considerable amounts since its lines showed up very strongly in the photographs in all of the brick.

Examination of the data with regard to the other five standards shows that none of them was present in the brick photographs.

The brick photographs, however, had certain lines which could not be accounted for by quartz, one of which was of particular interest. It occurred in all four of the factory brick samples made from shale (brick Nos. 4, 5, 6, and 7). It also occurred in No. 11 with rattler loss of 18.8%, and in Nos. 13 and 14 which gave high-grade brick when made by the usual processes. One other line, weaker than this line, occurred only in the above samples.

It thus appears that these two lines may be correlated with the toughness of shale paving brick, the tougher brick having more intense lines

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[1] D. A. Moulton, "Progress Report on Research of Paving Brick from Iowa Shales," *Jour. Amer. Ceram. Soc.*, **8** [11], 694–701 (1925).

[2] A. E. R. Westman, "An X-Ray Study of Fire Brick," Univ. of Illinois, Eng. Expt. Sta., *Bull.* No. 193, 1929.

[3] R. W. G. Wyckoff, The Structure of Crystals, pp. 239–42, The Chemical Catalogue Co., Inc., New York, 1931. 2d ed.

[4] Wyckoff, *loc. cit.*, pp. 325, 331.

than the weaker ones. It was interesting to note that the high-grade brick of No. 2 fire clay, No. 12, did not show either of these two lines.

The crystal producing these two lines was not determined.

The remaining lines, unaccounted for by quartz, are of general occurrence throughout all of the samples and are, therefore, probably due to some widespread ceramic material which has not been determined in the limited time available.

VI. Summary

An X-ray examination of a number of paving brick was made by the powder method. The powder photographs were then compared with those of quartz, cristobalite, alumina, mullite, sillimanite, and cyanite.

Proof of the presence of quartz and the absence of cristobalite, alumina, mullite, sillimanite, and cyanite was supplied.

A line falling at 2.03 ± 0.01 Ångström units was found to be characteristic of high-grade paving brick made from shales.

Acknowledgments The author wishes to acknowledge the advice and assistance of W. H. Jennings of the Department of Chemistry, Iowa State College; Paul E. Cox and D. A. Moulton of the Department of Ceramic Engineering, Iowa State College; the American Paving Brick Association; the Alton Brick Company, Edwardsville, Illinois; the Ava Brick Company, Ava, Ohio; the Hill Brick Company, East St. Louis, Ill.; the Metropolitan Paving Brick Co., Canton, Ohio; and the Toronto Fire Clay Company, Toronto, Ohio. The work was carried out in the Physical Chemistry Laboratory of Iowa State College, Ames, Iowa.

SELECTION OF CLAYS FOR SAGGERS OF PREDETERMINED RESISTANCE TO THERMAL SHOCK AND PREDICTION OF SAGGER LIFE IN SERVICE*

By R. A. Heindl and L. E. Mong

ABSTRACT

A series of twelve sagger bodies having a wide range in properties was prepared from fourteen different clays and grog made, in most instances, from the same clays. Experimental saggers heated to different temperatures were tested for resistance to thermal shock and the values compared with predetermined values assigned to each of the bodies. A chart was prepared which shows the relation between modulus of rupture, modulus of elasticity, linear thermal expansion, and resistance of saggers to thermal shock.

I. Introduction

The progress of the Bureau of Standards investigation of saggers and sagger clays has been reported periodically, the most recent of six reports[1] giving information relative to the effect on the life of the sagger when certain properties are varied.

As the problem neared completion the question naturally arose as to whether the manufacturer could conveniently apply the information obtained so as to produce saggers of desired quality.[2] Accordingly a chart was prepared, based on the modulus of rupture, modulus of elasticity in flexure, and linear thermal expansion of many sagger bodies studied during the course of the entire investigation. These properties give information relative to resistance to mechanical stress (modulus of rupture) and thermal shock $\left(\frac{\text{modulus of rupture}}{\text{modulus of elasticity}}\right.$ together with thermal expansion). The chart was then used as the basis for preparing a series of sagger bodies made with clays of which some of the properties were known. The object was to produce, if possible, saggers of predetermined resistance to thermal shock. This property is considered one of the most important factors controlling the life of the sagger in service. Although resistance to bulging under load (plastic flow) at high temperature is also an important factor in the life of the sagger, no effort was made to predetermine this property.

II. Method of Predetermining Resistance of Saggers to Thermal Shock and Preparation of Specimens

The bodies chosen for study in this phase of the investigation were classified prior to their preparation as either "good" or "poor," depending on whether it was anticipated that they would fail in a thermal shock test above or below 575°C, respectively (the approximate temperature of inversion of alpha to beta quartz). The classification was extended by assigning to each of the prospective bodies a temperature at which it was

* Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce. Received July 10, 1933.

[1] R. A. Heindl and L. E. Mong, *Jour. Amer. Ceram. Soc.*, **14** [12], 867–76 (1931); also Bur. Stand., *Research Paper* No. 387.

[2] Predicting the resistance of fire brick to thermal spalling has been discussed by F. H. Norton, *Jour. Amer. Ceram. Soc.*, **8** [1], 29–39 (1925); *ibid.*, **16** [8], 423 (1933); M. C. Booze and S. M. Phelps, *ibid.*, **8** [6], 361–82 (1925); K. Endell, *Glastech. Ber.*, **11** [5], 178 (1933).

believed the saggers would fail. These temperatures were obtained by computing the mean maximum outer fiber elongation $\left(\frac{\text{modulus of rupture}}{\text{modulus of elasticity}}\right)$ and the mean total linear thermal expansion between 20°C and 250°C of two sagger clays which had been heated at 1230°C and which were to be the constituent clays of the body. These mean values were plotted on the chart given in Fig. 1 and the approximate temperatures of failure

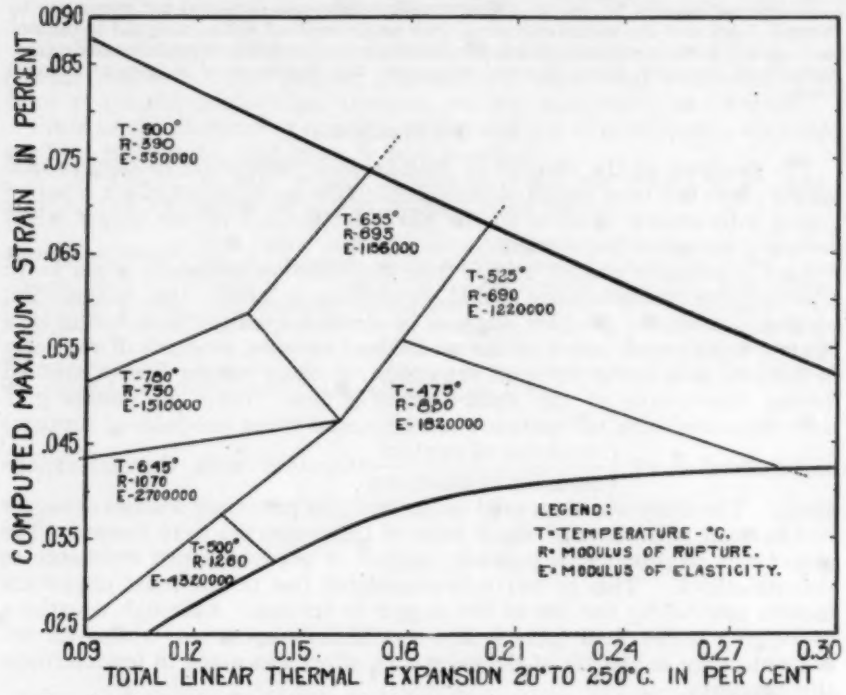

FIG. 1.—Areas showing the trend of the relation between resistance of saggers to failure due to thermal shock, *T*, modulus of rupture, *R*, modulus of elasticity in flexure, *E*, and linear thermal expansion. The values given represent the mean of numerous determinations which more or less blend from one area to the adjoining ones. No sagger bodies were made which fell outside the areas bounded by the heaviest lines. Data from over 70 sagger bodies were used in preparing this figure.

of the saggers in the air-quenching test deduced from their locations. These temperatures are given in Table I as "predetermined failing temperature."

Table I also contains information on a body (14CC) prepared with Georgia kaolin and grog made of the same material and the same body (15CC) to which was added 10% feldspar as flux. The Georgia kaolin was used because it was a relatively pure clay and the effect of differences in firing temperatures and additions of flux would be readily detected in test results.[3]

[3] R. A. Heindl, W. L. Pendergast, and L. E. Mong, "Kaolins: Effect of Firing Temperature on Some of Their Physical Properties," Bur. Stand., *Research Paper* No. 410.

The preparation of specimens and the methods of testing were similar in general to those described in the "Progress Report on Investigation of Sagger Clays."[4] The specimens and experimental saggers, preliminary to testing, were heated to the temperatures given in a footnote appearing in Table I.

III. Results Obtained with Selected Bodies

It may be noted from Table I (1) that in no case was an error made in the classification of the saggers as "good" or "poor" if based on the results for specimens heated at 1270°C; (2) that comparison is more logical than the use of results obtained on specimens heated at 1155°C, since the predictions were based on clays heated at 1230°C; and (3) that the temperatures at which it was predicted the respective experimental saggers would fail in the air-quenching test in general agreed very well with those actually obtained in the tests. Here again it is more logical to base the comparison on the results obtained on the specimens which were heated at 1270°C preceding the test.

A study of Table I gives the following information[5] by considering the bodies heated at two temperatures.

(*a*) Those heated at higher temperatures showed less resistance to thermal shock than those heated at lower temperatures with the exception of No. 11CC, although a difference of 15° may not be significant.

(*b*) The bodies exhibited less plastic flow after heating at the higher temperature than after heating at the lower temperature.

(*c*) The ratio of R/E or $\frac{\text{modulus of rupture}}{\text{modulus of elasticity}}$ is lower in the bodies heated at the higher temperature when compared with the values obtained for bodies heated at the lower temperature.

(*d*) The total linear thermal expansion to 250°C is greater for bodies fired at the higher temperature with the exception of bodies 11CC and 12CC.

Bodies 4CC and 5CC were prepared in an attempt to change the $\frac{\text{rupture}}{\text{elasticity}}$ or R/E ratio by varying only the grog content. Although the effort was successful, the saggers made from body 5 containing 68% grog showed only slightly greater resistance to thermal shock than the saggers made from body 4CC containing 25% grog. However, the comparatively small increase in failing temperature with increase of the R/E ratio of body 5CC in comparison with body 4CC may be attributed to the higher thermal expansion of body 5CC.

A comparison of the data for 14CCL and 14CCH is unusually enlightening. When saggers which were made from a practically pure clay were heated at 1300°C instead of 1200°C, it caused changes as follows: the R/E ratio, the plastic deflection, and the Centigrade temperature at which the saggers failed in the quenching test were almost halved and the total expansion between 20°C and 250°C was just about doubled.

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[4] R. A. Heindl and L. E. Mong, *Jour. Amer. Ceram. Soc.*, **12** [7], 457–80 (1929).

[5] Only a part of the available information relative to the clays and sagger bodies is given. The data represent those considered necessary for the conclusions reached. Anyone interested in additional information may secure this from the Bureau of Standards by correspondence.

TABLE I

PROPERTIES OF SAGGERS AND SAGGER BODIES

Sagger[a] body No.	Bond[b] clay No.	Classed (good or poor)[c]	Predetermined failing temperature (°C)	Actual failing temperature (°C)	Modulus[d] of Rupture R (lb./in.^{2})	Modulus[d] of Elasticity[e] E (1000 lb./in.^{2})	R/E[f] (%)	Total linear thermal expansion 20–250°C (%)	Plastic deflection at 1000°C (inches) ($\times 10^{-4}$)[g]	Porosity (%)
1CCL	42			885	535	1040	0.0515	0.109	18.0	33.4
1CCH	45	Good	800	790	810	1790	.0453	.138	5.0	25.0
2CCL	11			980	325	390	.0834	.097	15.0	42.2
2CCH	19	Good	650	585	360	615	.0585	.242	7.5	41.0
3CCL	32			600	595	1060	.0562	.168	10.0	32.8
3CCH	41	Poor	425	475	870	2025	.0429	.217	2.0	24.3
4CC	5			475	2050	7820	.0263	.110	5.0	7.3
5CC	35			505	1290	4095	.0315	.134	3.0	20.2
8CCL	41			585	370	650	.0569	.210	8.0	39.6
8CCH	50	Poor	400	450	740	1760	.0421	.283	3.0	29.3
9CCL	40			575	465	910	.0512	.252	13.0	37.9
9CCH	41	Poor	450	425	725	1415	.0512	.293	1.5	30.3
10CCL	19			965	265	370	.0716	.160	6.0	44.6
10CCH	31	Good	700	880	250	440	.0568	.205	2.5	42.3
11CCL	15			690	910	2405	.0378	.115	25.0	21.7
11CCH	42	Good	750	705	1435	3935	.0365	.090	20.0	15.6
12CCL	5			535	870	2575	.0338	.128	10.0	22.3
12CCH	43	Poor	400	490	830	3005	.0277	.124	9.0	20.9
14CCL	Georgia kaolin	Good		960	120	160	.0750	.122	4.0	42.6
14CCH		Poor		495	355	800	.0445	.248	2.5	41.7
15CC	Georgia kaolin Feldspar			490	325	755	.0431	.200	8.0	40.1

[a] Bodies 4CC and 5CC were fired at 1230°C (cone 10); 14CCL at 1200°C (cones 8 to 9); 14CCH and 15CC at 1300°C (cones 12 to 13). All other bodies were fired at the following two temperatures: 1155°C (cone 6) indicated by *L*, and 1270°C (cone 12) indicated by *H*. All bodies contain equal amounts by weight of clay and grog except bodies 4CC and 5CC (about which see text). Similar combinations of grog identified as "coarse" in preceding reports used (see text footnote 1, p. 601).

[b] Identification numbers of clays correspond to those used in preceding reports (see text footnote 1, p. 601).

[c] This classification concerns only relative resistance to failure as caused by thermal shock and should not be confused with relative "life" considered in Fig. 1.

[d] Tested at room temperature.

[e] Values given are for modulus of elasticity in flexure and represent the average of two determinations neither of which varied more than 10% from the mean.

[f] $R/E = \frac{\text{modulus of rupture}}{\text{modulus of elasticity}}$ = maximum outer fiber strain.

[g] Total plastic deflection at the center of a bar one inch square over a 10-in. span and a stress of approximately 120 lb./in.^{2} (actual load 7.5 lb. at center of span). Values given to be multiplied by 10^{-4} or 0.0001.

The modulus of elasticity was decidedly increased but the change in modulus of rupture was small and the change in porosity almost negligible. These changes in properties were undoubtedly due to the formation of mullite and cristobalite in the kaolin when heated at the higher temperature. The feldspar in body 14CCH did not decrease the thermal expansion sufficiently, as shown by body 15CC, to make any difference in the temperature at which saggers cracked in the air-quenching test. The small amount of flux, however, caused a decided increase in the plastic flow of the body at 1000°C.

IV. Application of Accumulated Results to Prediction of Sagger Life in Service

The method of using Fig. 1 for predicting the resistance of saggers to heat shock has been explained in preceding paragraphs. This chart shows to the manufacturer of saggers how certain important physical properties may affect the life of saggers. For instance, an examination of the left side of the figure shows that for saggers having the same total expansion to 250°C, those showing the greatest resistance to thermal shock have both a comparatively low modulus of rupture and a low modulus of elasticity. As the lower lefthand corner is approached, both strength and modulus of elasticity increase, but unfortunately the latter increases at a much greater rate than the former. This means that the ultimate "stretch" before rupture is decreasing rapidly, which in turn causes the saggers to have a lower resistance to thermal shock, *T*. The values of *T*, obtained by subjecting saggers to thermal shock in an air-quenching test,[6] should be considered only relative because their magnitude will depend, for example, partially on the percentage or sizing of grog in the body. As is evident from the chart, however, the determination of *T* is not necessary since the several areas always bear the same relation to one another, and the location of a sagger body on the chart is determined by its *R/E* and thermal expansion values and its relative location gives an indication of its quality.

[6] See footnote 1, p. 601.

Probably the most satisfactory sagger bodies for general purposes occur in the area near the middle of the left side of the chart where T equals 780°C, R equals 750 pounds per square inch, and E equals 1,510,000 pounds per square inch. A satisfactory resistance to thermal shock is combined with a strength suitable for resistance to mechanical breakage. The modulus of rupture of 750 pounds per square inch comes within the range of values obtained on testing a number of commercial sagger bodies indicating that such a transverse strength must be satisfactory in plant practice.

Results obtained in laboratory tests of twelve commercial sagger bodies showed six to have properties which placed them in the lower center area (Fig. 1) where T is 475°C, three in the area on the upper right where T is 525°C, and the other three in the upper center area where T is 655°C. Furthermore results recently obtained with two commercial bodies submitted by a manufacturer confirmed information on service life as indicated by the plant records of the manufacturer.

V. Summary and Conclusions

A series of twelve sagger bodies was prepared from selected clays and, after heating at either one or two temperatures, was tested for modulus of elasticity, transverse strength, linear thermal expansion, plastic deflection, and porosity. Experimental saggers made from these bodies were tested for resistance to thermal shock and the results compared with predetermined values assigned to each of the sagger bodies and obtained from a study of properties of the clays making up the bodies.

Data are presented graphically which it is believed will permit the manufacturer of saggers to predict with a reasonable degree of accuracy the relative length of service which may be expected from saggers made from combinations of clays of which some of the properties have been determined.

CERAMIC ABSTRACTS[1]

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Vol. 12 **October-November, 1933** **No. 10-11**

Abrasives

Flat grinding machines and their application. I. CARL MOREY. *Abrasive Ind.*, **14** [6], 6–7 (1933).—The development of flat grinding is discussed. Several types of flat grinding machines and devices for obtaining accuracy are described. Illustrated. II. *Ibid.*, **14** [7], 11 (1933).—This is an illustrated description of some flat grinding machines and their application. III. *Ibid.*, **14** [8], 10 (1933).—The use of wheel periphery differs in action from the other types due to the smallness of wheel contact. The application of this type is discussed and illustrated. IV. *Ibid.*, **14** [9], 10 (1933).—Vertical and horizontal spindles which form two basic types in grinding with the side of the wheel are discussed. Illustrated. C.H.T.

Wheel grinder. F. A. WESTBROOK. *Abrasive Ind.*, **14** [8], 22 (1933).—A method for grinding the periphery and hubs of chilled car wheels in one setting is described. Illustrated. C.H.T.

Abrasive inventions. ANON. *Abrasive Ind.*, **14** [8], 24 (1933).—A caliper device with special bearings which permits grinding automatically to close tolerances is described. Illustrated. C.H.T.

Abrasives used in watch making. ANON. *Abrasive Ind.*, **14** [8], 8 (1933).—A description of the watch making processes to which abrasives are applied for fine grinding and polishing is given. Illustrated. C.H.T.

Progress in abrasive tools. ANON. *Abrasive Ind.*, **14** [6], 27 (1933).—Grinders, a rubber bonded abrasive, safety tread, and a new motor base providing sound isolation are described. Illustrated. *Ibid.*, **14** [7], 27 (1933).—New grinder features, *i.e.*, roll scouring brick shape, motor and speed reducer, pneumatic tool for polishing the ends of tubes, whipcord cone belt base, starting switch for fractional motors, twin suction intake for coolant pumps, and a new cutting machine, are described. Illustrated. *Ibid.*, **14** [8], 27 (1933).—Check for working gages, belt with no inelastic stretch, tape rule, lapping machine with a vertical spindle, reclosing device for circuit breakers, oil- and heat-resisting cable, magnet for removing iron and steel chips from the eye, and variable speed buffer, polisher, and grinder are described. Illustrated. C.H.T.

British machine tools. ANON. *Machinery* [London], **39** [1001], 365–72 (1931).—A centerless grinder has the work feeding between opposed faces of two cup or ring wheels. The feed wheel is obliquely set in relation to the grinding wheel, and the dispositions are such that the points of contact between the respective wheels and the work are not opposite each other; consequently, inaccurate stock does not tend to perpetuate its faults but gradually becomes true. F.G.H.

Inspection and testing of machine tools. G. SCHLESINGER. *Machinery* [London], **40** [1022], 182–85 (1932).—S. presents testing charts for cylindrical and planer-type surface grinders and universal tool and cutter grinders with data on permissible errors and tolerances for principal parts of machines. F.G.H.

Polishing powders and earths. ARTHUR JONES. *Sands, Clays, & Minerals*, **1** [4], 47–50 (1933).—The earths and powders employed for polishing are (1) clays classified according to specific uses such as ball clays, bleaching clays, and pipe clays (benton-

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.
The bold-face number following the journal name is the volume, the issue number is in brackets, followed by the page numbers, then the year in parentheses.

ite, devolite, and stockalite are highly colloidal clays); (2) chalks and whitings, natural powders consisting essentially of carbonate of lime and prepared from various mineral rocks; (3) cutter-fish, consisting of 89% carbonate of lime, 10% organic matter, and traces of other materials; (4) rottenstone, a mineral powder of a dirty brick color formed by the weathering of limestone and containing a large proportion of alumina and some iron; (5) French chalk, called also steatite or soapstone, a natural talc or soft silicate of magnesium; (6) silica flosses, or kieselguhr; (7) tripoli powder, an impalpable siliceous earth resulting from the weathering of a siliceous limestone, "chert," which is similar in composition to diatomaceous earth but contains less hydrated water and is very absorbent; (8) rouges, amorphous forms of nearly pure ferric iron oxides; (9) pumice powder, the ground form of a porous lava of volcanic origin which consists of silicate of aluminium; (10) bath brick or brick dust; (11) silicon carbide produced by the electric furnace; (12) Vienna lime, a white calcinated limestone; and (13) chromium oxide. M.V.K.

Apparatus for testing the grinding power of abrasive powders. G. G. LEMMLEIN. *Mineral. Suir'e*, **7** [11–12], 41–43 (1932).—The apparatus of Mindt is somewhat simplified. (*C.A.*)

Natural and artificial abrasive materials. M. I. KOĬFMAN. *Mineral. Suir'e*, **7** [7–8], 59–67 (1932).—A review is presented. (*C.A.*)

Hard rubber parts ground by centerless method. ANON. *Abrasive Ind.*, **14** [9], 9 (1933).—Illustrated. C.H.T.

Finishing of auto clutch plates by precision grinding. ANON. *Abrasive Ind.*, **14** [9], 8 (1933).—The manufacture of auto clutch plates and the necessity of finishing them by precision grinding is discussed. Illustrated. C.H.T.

Accuracy in camshaft grinding. ANON. *Abrasive Ind.*, **14** [9], 6 (1933).—The production of camshafts for automobiles is described and the method by which they are ground is discussed. Illustrated. C.H.T.

Grinding and grading tapered bearing rollers. ANON. *Machinery* [London], **38** [970], 193–96 (1931).—Grinding operations on centerless grinding machines are described with particular reference to the feeding arrangement. Data on tolerances and output are given. F.G.H.

Grinding teeth of large gears. G. E. KATZENMEYER. *Abrasive Ind.*, **14** [8], 6 (1933).—Application of ground-tooth gearing to electric locomotives provides an excellent conception of the rapid progress being made in tooth grinding since gears of such large size are heat treated for high hardness and toughness and held to exceptionally close tolerances. The gears and the method of grinding are described. Illustrated. C.H.T.

Grinding valve seat inserts with special fixtures. FRED B. JACOBS. *Abrasive Ind.*, **14** [7], 14 (1933).—Illustrated. C.H.T.

Grinding bars with precision. EDWARD S. HECK. *Abrasive Ind.*, **14** [7], 8–9 (1933).—The processes employed in producing ground bars, from the standpoint of precision grinding, are described. Illustrations are included of the Union Drawn Steel Co. C.H.T.

Grinding large roller races. ANON. *Abrasive Ind.*, **14** [8], 20 (1933).—Uniform wall thickness is produced by grinding both diameters at the same time. The grinding process and the product are described. C.H.T.

Grinding salvages small tools. FRED B. JACOBS. *Abrasive Ind.*, **14** [8], 12 (1933).—A means of reclaiming milling cutters and other small tools without elaborate equipment is described and illustrated. C.H.T.

Grinding with limited equipment. H. J. CHAMBERLAND. *Abrasive Ind.*, **14** [8], 23 (1933).—The application of grinding in the maintenance of keyway broaches is described. Illustrated. C.H.T.

Variety of grinding in modern foundry. ANON. *Abrasive Ind.*, **14** [6], 12 (1933).—The types of grinding to be done in modern foundry work are described. Illustrated. C.H.T.

Making gages for automobile rims. FRED B. JACOBS. *Abrasive Ind.*, **14** [6], 14 (1933).—The requirements of extreme accuracy in the gages are met by grinding. The rim-making process, showing the necessity for gages, is described and some special grinders are discussed. Illustrated. C.H.T.

New process developed for coated abrasives. DONALD WANDREI. *Abrasive Ind.*, **14** [9], 16 (1933).—The process and results of electrical orientation of abrasive grains are described and discussed. Illustrated. C.H.T.

Finishing Monel metal and nickel. I. W. F. BURCHFIELD. *Abrasive Ind.*, **14** [6], 13 (1933).—The cycle of operations in finishing Monel metal and nickel is deter-

mined by the type of article, desired finish, and equipment available. Equipment and grinding media are discussed. II. *Ibid.*, **14** [7], 13 (1933).—A number of methods that have been successfully employed in finishing types of Monel metal and nickel is described. C.H.T.

Equipment affects set-up time. A. J. BRANDT AND C. J. ABBOT. *Abrasive Ind.*, **14** [6], 8–9 (1933).—The many factors involved in the proper selection of machines and equipment for job order shops and the relation of machine selection to set-up time are discussed. C.H.T.

BOOK

Sparks from the Electrode. C. L. MANTELL. Century of Progress Series. Williams and Wilkins Co., Baltimore, 1933. 127 pp. Price $1.00. Reviewed in *Ind. Eng. Chem.*, **25** [7], 830 (1933).—Chapters on the production of artificial abrasives and graphite, the development of electro-furnaces, and their principal utilization are included in this volume. F.G.H.

PATENTS

Borosilicate bonded aluminous abrasive. C. E. WOODDELL (Carborundum Co.). U. S. 1,918,312, July 18, 1933. A bonded abrasive article comprises abrasive grains and a bond consisting principally of a borosilicate glass in which the coefficient of expansion of the bond is less than that of the grain by substantially more than 20%.

Abrading machine. H. L. CHAPIN (United Shoe Machinery Corp.). U. S. 1,918,321, July 18, 1933.

Abrading wheel and mounting therefor. F. J. HOHNHORST AND F. J. KROEGER. U. S. 1,918,392, July 18, 1933.

Method of producing abrasive paper, etc. CARL MÜNCH. U. S. 1,918,418, July 18, 1933.

Sharpening device for slicing-machine knives. C. F. M. VAN BERKEL (U. S. Slicing Machine Co.). U. S. 1,918,575, July 18, 1933. A. VAN DUYN (U. S. Slicing Machine Co.). U. S. 1,918,576, July 18, 1933.

Gin rib grinding machine. JOSEPH BEHLE (The Murray Co.). U. S. 1,918,584, July 18, 1933.

Machine for grinding the edges of watch glasses. PAUL REUSSER. U. S. 1,918,668, July 18, 1933.

Internal cylinder grinding tool. ERICH MARX. U. S. 1,918,852, July 18, 1933.

Grinding machine. C. J. ANDERSON. U. S. 1,918,951, July 18, 1933. G. W. BINNS (Cincinnati Grinders, Inc.). U. S. 1,919,143, July 18, 1933, and 1,924,593, Aug. 29, 1933. CLEMENT BOOTH (Cincinnati Grinders, Inc., and Heald Machine Co.). U. S. 1,919,144, July 18, 1933, and 1,919,615, July 25, 1933. GEORGE GORTON. U. S. 1,920,073, July 25, 1933. W. L. BRYANT (Bryant Chucking Grinder Co.). U. S. 1,920,290, Aug. 1, 1933. L. B. STOGNER (Sonoco Products Co.). U. S. 1,921,333, Aug. 8, 1933. E. J. WHALEN (Aluminum Co. of America). U. S. 1,921,714, Aug. 8, 1933. W. K. MORTON. U. S. 1,922,817, Aug. 15, 1933. J. A. SMITH (U. S. Electrical Tool Co.). U. S. 1,923,760, Aug. 22, 1933. C. C. STEVENS (New Departure Manufacturing Co.). U. S. 1,923,762, Aug. 22, 1933. D. F. JONES (Gardner Machine Co.). U. S. 1,923,931, Aug. 22, 1933. A grinding machine for polygonal sided work pieces is described. TOM ADDISON (Cincinnati Grinders, Inc.). U. S. 1,924,588, Aug. 29, 1933. H. H. YERK AND A. A. KOTTMAN (Micro Corp.). U. S. 1,924,896, Aug. 29, 1933. J. K. E. DIFFENDERFFER (Carr-Lowrey Glass Co.). U. S. 1,925,751, Sept. 5, 1933. ROBERT REID AND A. S. REID. U. S. 1,925,908, Sept. 5, 1933.

Flexible shaft bench grinder. A. B. BACHMANN AND WILLIAM KRAUSE (Pratt & Whitney Co.). U. S. 1,918,952, July 18, 1933.

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Method and apparatus for truing a grinding wheel. S. W. BATH (John Bath & Co.). U. S. 1,919,288, July 25, 1933.

Planetary type surfacing machine. H. L. MYERS (American Floor Surfacing Machine Co.). U. S. 1,919,389, July 25, 1933.

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Lathe and method of turning round bodies. C. H. NORTON (Norton Co.). U. S. 1,920,209, Aug. 1, 1933.

Feeding mechanism for machine tools. W. H. WOOD (Norton Co.). U. S. 1,920,-

228, Aug. 1, 1933. W. F. FRASER (Norton Co.). U. S. 1,920,979, Aug. 8, 1933. CARROLL KNOWLES (Pratt & Whitney Co.). U. S. 1,923,786, Aug. 22, 1933.

Method of making combined abrasives and holders. M. C. HUTTO (Hutto Engineering Co., Inc.). U. S. 1,920,986, Aug. 8, 1933.

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Gear wheel lapping tool. T. R. RIDEOUT (Westinghouse Electric & Mfg. Co.). U. S. 1,924,380, Aug. 29, 1933.

Abrasive applying machine. OWEN DOUTT (General Spring Bumper Corp.). U. S. 1,924,487, Aug. 29, 1933.

Surfacing machine. W. H. WINEMANN (Sullivan Machinery Co.). U. S. 1,924,582, Aug. 29, 1933.

Cutter grinder. H. R. ISLER (Cincinnati Milling Machine Co.). U. S. 1,924,608, Aug. 29, 1933.

Preformed abrasive and process of producing. E. S. MERRIAM. U. S. 1,924,648, Aug. 29, 1933. A process for producing preformed aluminous abrasives comprises bonding aluminum oxide grains by additional aluminum oxide formed *in situ* by the burning of metallic aluminum in an atmosphere of oxygen.

Abrasive body and method of making. E. E. NOVOTNY AND J. N. KUZMICK (John Stogdell Stokes and Raybestos-Manhattan, Inc.). U. S. 1,924,748, Aug. 29, 1933. An abrasive composition comprises abrasive granules, a thermosetting resin, and an alcohol of the furfuryl-benzyl class.

Abrasive disk. A. J. DOERMANN (Titan Abrasives Co.). U. S. 1,924,773, Aug. 29, 1933.

Valve-seat grinder. A. M. PATTERSON (J. W. Byrd and J. L. Byrd). U. S. 1,924,958, Aug. 29, 1933.

Automatic knife sharpener. LOUIS NAGY (Stephen F. Halach). U. S. 1,925,108, Sept. 5, 1933.

Hydraulic chuck. C. W. OLSON (H. A. Tomkins). U. S. 1,925,109, Sept. 5, 1933.

High-speed shaping machine with hydraulic drive. ERWIN STURM. U. S. 1,925,215, Sept. 5, 1933.

Cylinder grinding tool. H. W. ZIMMERMAN (Automotive Maintenance Machinery Co.). U. S. 1,925,709, Sept. 5, 1933.

Method of grinding crankshafts. A. P. STEINER (Landis Tool Co.). U. S. 1,925,911, Sept. 5, 1933.

Razor blade sharpening device. CHARLES MINERS. U. S. 1,925,983, Sept. 5, 1933.

Bonded articles such as abrasive wheels and methods of making them. CARBORUNDUM CO., LTD. Brit. 394,667, July 12, 1933.

Bonded refractory and abrasive articles such as abrasive wheels, and methods and means for making them. CARBORUNDUM CO., LTD. Brit. 394,668 and 394,669, July 12, 1933.

Grinding machines. W. W. TRIGGS (Norton Co.). Brit. 395,253, July 19, 1933.

Machines for grinding and polishing carding flats. P. WOLTERS. Brit. 395,261, July 19, 1933.

Machines for grinding small bores or holes. J. SUNNEN. Brit. 395,271, July 19, 1933.

Machine for sharpening razor blades. M. WLOKA. Brit. 395,446, July 26, 1933.

Valve-grinding tools. F. SLATER AND E. HUMPHREYS. Brit. 395,829, Aug. 2, 1933.

Device for truing grinding disks. K. GALLIEN. Brit. 395,895, Aug. 2, 1933.

Machine for testing abrasive qualities of materials and for testing lubricants. TIMKEN ROLLER BEARING CO. Brit. 395,976, Aug. 2, 1933.

Abrasive wheels, etc. CARBORUNDUM CO., LTD. Brit. 396,060, Aug. 10, 1933.

Abrasive tools and methods and apparatus employed in their manufacture. O. S. BUCKNER. Brit. 396,231, Aug. 10, 1933.

Process and apparatus for manufacture of abrasive articles. BEHR-MANNING CORP. Brit. 396,385, Aug. 16, 1933.

Boring, grinding, etc., machines. J. SALMON. Brit. 396,473, Aug. 16, 1933.

Grinding or abrading machines. CHURCHILL MACHINE TOOL CO., LTD., AND H. H. ASBRIDGE. Brit. 396,478, Aug. 16, 1933.

Portable electric grinding machines. R. BOSCH AKT.-GES. Brit. 396,619, Aug. 16, 1933.

Abrading or surfacing. H. R. STRATFORD. Brit. 397,160, Aug. 30, 1933.

Apparatus for preparing corundum, etc. A. T. FEDOROV, K. S. KNAPSKII, AND V. V. IL'IN. Russ. 28,905, July 1, 1924. Construction details are given. (*C.A.*)

Art and Archeology

Colorimetry of pigments. G. F. NEW. *Trans. Ceram. Soc.* [Eng.], **32** [3], 95–112 (1933).—Necessary and sufficient parameters for colorimetry can now be supplied by a system of three primary colors as the end members of a triaxial representing mixtures of the three. For purposes of standardization the three primary colors selected by the National Physical Laboratory are a spectral red, green, and blue, these being chosen to include as large as possible a range of real colors. The actual green and blue are the spectral lines of these colors given by the mercury arc at 0.546μ and 0.436μ. The red spectral line has a wave-length of 0.700μ. This system is applied to ceramic materials and paint pigments in tests made with the Guild colorimeter. Tables and illustrations. See also *Ceram. Abs.*, **12** [6], 214 (1933). C.H.T.

Methods of color measurement. A. KLUGHARDT AND MANFRED RICHTER. *Arch. Tech. Mess.*, **2**, T64–65 (May, 1933).—Seven methods of color measurement are briefly described, *i.e.*, trichromatic colorimeter, direct color matching, spectrophotometer, spectral colorimeter, Bloch's method, Ostwald's method, and objective methods using photocells. The descriptions are in general terms and an attempt has been made to cover most of the important methods in current use. There is an extensive bibliography. (*Rev. Sci. Inst.*)

Glazes for majolica plates. KARL THON. *Keram. Rund.*, **41** [2], 18–20 (1933).—Pure soda glazes are soft and tend to form cracks or swellings on the edges. The introduction of potassium oxide as saltpeter or feldspar is recommended; the latter should be used only for glazes containing alumina. A large amount of alkalis requires a high silica and alumina content; this is also true for lime which requires boric acid and a lower tin oxide content. In glazes poor in lime and rich in lead, boric acid should not be used as it lowers the opacifying action of tin oxide. Tin oxide is the best opacifier because majolica plates are fired at lower temperatures. Glazes opacified with tin oxide must have a high lead content. Among fluorides, cryolite is the most employed. It is often used with lead tin glazes. Antimony preparations require glazes free from lead. Glazes opacified with phosphates may contain lead but must have a high sodium content, some boric acid, and little silica. Arsenious acid is a good opacifier for glazes rich in lead and poor in alumina and silica. Zirconium oxide is used for lead-alkali glazes containing lime, magnesia, boric acid, and a little silica. Alumina is also a good opacifier in some cases. Directions for preparing, firing, and coating are given. M.V.K.

Effect of fineness of grinding on the intensity of color and luminosity of underglaze colors. E. M. *Sprechsaal*, **66** [25], 421–22 (1933).—The fineness of grinding of the color is of importance up to a certain point where its effect remains constant. The glaze becomes quite luminous when the correct glaze and thickness are employed; too thickly glazed colors produce turbid color tones. The thickness of the layer of color is important; colors applied too thickly absorb the glaze, while too thinly applied colors have no luminosity and no depth of color. A previously determined firing temperature is important. M.V.K.

Decorating ceramic ware by a new process. H. WELTE. *Ceram. Age*, **22** [1], 8–9 (1933).—The application of colors to porous white ceramic bodies by means of solutions of metal salts is discussed. The variety of designs is unlimited and the reproduction of definite designs can be made accurately. The process is limited by the fact that a transparent glaze must be employed over the decoration. F.G.H.

Sandblasting for decorating glassware and pottery. C. EARL AVERY. *Ceram. Ind.*, **21** [2], 81–82 (1933).—A. discusses the process in vogue for decorating glass bottles, sheet glass, or ceramic tile by sandblasting monograms, illustrations, etc., thereon. The

fine grade of sandblast decoration is done by use of "dope" over the glass with the stencil cut out of it; large quantity production is done with rubber or metal stencils. Illustrated. E.J.V.

Art of pressing glass: an American heritage. E. G. NOCK. *Crockery & Glass Jour.*, **112** [5], 11–12 (1933).—This story of native art is the first of a series of articles on the technical processes involved in the manufacture of glass and china. Methods of eliminating mold marks and the processes of manufacture and finishing are described. Illustrated. C.H.T.

Right out of the kiln. KAY. *Crockery & Glass Jour.*, **112** [4], 18–25 (1933).—New designs in glass and pottery mugs, steins and pitchers, and glass and china dinnerware service, both domestic and imported, are described. Illustrated. C.H.T.

New architecture in dinnerware. ANON. *Ceram. Age*, **22** [1], 12 (1933).—New shapes and designs in a heat- and cold-resistant dinnerware are described and illustrated. F.G.H.

Decorative art of today. ANON. *Pottery Glass Rec.* [Eng.], **15** [6], 170–75 (1933).—The present decorative art in pottery and glassware is discussed. Illustrated. M.V.K.

Hopewell type pottery from Louisiana. F. M. SETZLER. *Jour. Wash. Acad. Sci.*, **23**, 149 (1933).—A detailed description is given of pottery and associated artifacts excavated near Marksville in the Red River Valley of Louisiana and believed to belong to the Hopewell culture of the Upper Mississippi Valley. J.B.A.

Improved design in British pottery. ANON. *Times Eng. Supp.*, **32**, 352 (1933).—At the exhibition of British Industrial Art, London, a Wedgwood coffee set in black and white with monogram in silver was selected as the best example of craftmanship in any material. H.H.S.

Preservation of objects of antiquity. H. F. CLELAND. *Sci. Monthly*, **37**, 50–53 (1933). H.H.S.

Harry Clarke, artist and craftsman. LEO CARTWRIGHT. *Stained Glass*, **28** [1], 29–32 (1933).—A short description is given of the works of Harry Clarke on stained glass. M.V.K.

Window in the chapel of Carterbury school. RAPHAEL HUME. *Stained Glass*, **28** [1], 51–53 (1933).—A description is given of the west window for the chapel of the Carterbury school, New Milford, Conn., designed and made by Nicolas D'Ascenzo. Illustrated. M.V.K.

Great rose window. MILO HUDSON GATES. *Stained Glass*, **28** [1], 23–27 (1933).—G. describes the great rose window recently placed in the western front of the Cathedral of Saint John the Divine, New York. M.V.K.

The iconography of the seven liberal arts. DONALD LEMEN CLARK. *Stained Glass*, **28** [1], 3–17 (1933).—C. describes in detail W. H. Brumham's seven arts window to be placed in the Knowles chapel at Rollins College. It is an allegorical representation of the seven liberal arts of classical education: grammar, rhetoric, logic, arithmetic, geometry, music, and astronomy. M.V.K.

Early pottery as ornaments. LURA WOODSIDE WATKINS. *Christian Sci. Mon.*, **25** [95], 7 (1933).—The use of utilitarian ware of small New England potteries for ornamental purposes is discussed. The New England pottery is of two types, stoneware in gray or brown and glazed red ware. Jugs, jars, and bowls of this type are useful in decoration. E.J.V.

Esthetic values in "Sandwich" glass. CARL GREENLEAF BEEDE. *Christian Sci. Mon.*, **25** [201], 7 (1933).—Some of the earlier types of Sandwich glass which had pleasing outlines and decorations are discussed, the general degeneration of the beauty of design that followed in the later types being pointed out. Illustrated. E.J.V.

Glass men of Beni Hassan. M. D. *Glaces et Verres*, **6** [33], 10–11 (1933).—The paintings discovered in Beni Hassan, Egypt, about 4000 years old, do not represent glass blowers as was heretofore assumed but simply represent the activation of fire in a hearth of a forge. M.V.K.

Pottery finds at Rhodes. G. JACOPI. *Illus. London News*, **182**, 712–14 (1933).—Beautiful pottery of the second millenium B.C. has been found by J., who is superintendent of excavations in the Italian islands of the Ægean Sea. See also *Ceram. Abs.*, **12** [1], 6 (1933). H.H.S.

Lost civilization discovered near Nineveh. M. E. L. MALLOWAN. *Illus. London News*, **182**, 686 (1933).—Relics of the 5th millenium B.C. at Tal Arpachiyah, near Nineveh, include magnificent painted pottery. See also *Ceram. Abs.*, **11** [12], 603 (1932). H.H.S.

Excavations at Uaxactun. O. G. RICKETSON, JR. *Sci. Monthly*, **37**, 72–86 (1933).—

Of the three aboriginal New World civilizations, Aztec, Inca, and Maya, the Maya was intellectually the highest. 12 illustrations. H.H.S.

Eskimo "Golden Age" revealed. H. B. COLLINS, JR. *Illus. London News*, **182**, 760–61 (1933).—Smithsonian finds on the Bering Sea demonstrate definite evidence of an ancient culture. 6 photographs. H.H.S.

Tell-el-Amarna finds. J. D. S. PENDLEBURY. *Illus. London News*, **182**, 629–33 (1933); see also *Ceram. Abs.*, **12** [2], 44 (1933). H.H.S.

Second Robineau show. ANON. *Ceram. Age*, **21** [6], 169 (1933).—The second annual Robineau Memorial Exhibition is described and the prize winning exhibits are illustrated. F.G.H.

Sturgis collection of ornamental Wedgwood. C. LOUISE AVERY. *Crockery & Glass Jour.*, **112** [4], 27–28 (1933).—Fourteen pieces including nine blue jasper vases in the Frank K. Sturgis gift are described by one of the curators of the Metropolitan Museum of Art. Illustrated. C.H.T.

BOOKS

A Handbook to the Palace of Minos at Knossos. J. D. S. PENDLEBURY. With foreword by Arthur Evans. 63 pp. 14 plates, 8 plans. Macmillan & Co., London, 1933. Price 4s. Reviewed in *Times Lit. Supp.*, **32**, 363 (1933). H.H.S.

Tell Halaf. MAX VON OPPENHEIM. Translated by G. Wheeler. xvi + 337 pp. Plates. G. P. Putnam's Sons, London, 1933. Price 21s. Reviewed in *Times Lit. Supp.*, **32**, 394 (1933).—O. tells of the excavation of a culture in oldest Mesopotamia. See also *Ceram. Abs.*, **11** [8], 439 (1932). H.H.S.

Book Review

Masterpieces of Pottery and Porcelain in Japan. SEIICHI OKUDA. 2 vols. 50 color plates. $50.00. Published by Meiji-Shobo, 8, Nichome, Harukicho, Hongow, Tokyo, Japan. "Chadō," the art of preparing and serving Japanese green tea, has developed since 700 years ago. As a rule, those who are interested in "chado" also enjoy the art of floral arrangement and the collection of antiques. Old Japanese families possess rare utensils for serving tea, each valued at several thousand yen, which are handed down from generation to generation, and they pride them as symbols of their family name. No other people prize and appreciate earthenware as do the Japanese. They have made famous earthenware that is unusually lovely and "shibui," a word used in "chado" to mean refinement. In this book are shown rare and prized articles of special lovers of earthenware that can not ordinarily be seen. The author is a graduate of the Tokyo Imperial University, College of Æsthetics. Through his study and research, he ranged over the literature of earthenware, thus enabling him to publish this book. Originally, in Japan, pottery makers who could put their signatures on their works were regarded as artists. In this book are introduced the masterpieces of these experts. Besides the picture value of the articles, this book also possesses the encyclopedic and historic values of earthenware. This book is a pastime publication of a few volunteers who are interested in china and porcelain. Only a limited number of copies has been printed and there will be absolutely no reprints made of them. These articles in Japan were kept as the family treasure and were not made public for a long time. They are treasured now in storehouses and are taken out only in welcoming special guests. Even artists are not allowed to see them. These hundred pictures were taken after getting permission one by one from the owners. They are the first and probably the last attempt even in Japan. There are only eighty copies of them to be sold in foreign countries. Three hundred choice examples of oriental art, ancient and medieval pottery and porcelain are illustrated.

PATENTS

Design for combined bathtub and shower pan. J. E. DRUCKENMILLER. U. S. 90,361, July 25, 1933.

Design for plate, etc. HERBERT MOLLER (Indiana Glass Co.). U. S. 90,374, July 25, 1933.

Design for bowl, etc. HERBERT MOLLER (Indiana Glass Co.). U. S. 90,375, July 25, 1933.

Design for glass jar. F. J. PETTY (Ball Brothers Co.). U. S. 90,379, July 25, 1933. FRASIER SMITH (Hazel-Atlas Glass Co.). U. S. 90,512, Aug. 15, 1933.

Design for goblet, etc. E. M. BOTTOME (Fostoria Glass Co.). U. S. 90,471, Aug. 15, 1933. J. O. ARDUSER (D. C. Jenkins Glass Co.). U. S. 90,520, Aug. 22, 1933.

Pottery and method of making. M. G. TARTER AND A. L. ROSE. U. S. 1,918,496, July 18, 1933.

Design for electric casserole. A. T. SMITH (National Enameling & Stamping Co.). U. S. 90,388, July 25, 1933.

Design for bottle. J. F. INFIELD (California Consolidated Water Co.). U. S. 90,619 and 90,620, Sept. 5, 1933.

Apparatus for measuring color. DOROTHY NICKERSON. U. S. 1,924,747, Aug. 29, 1933.

Process of imitating onyx, marble, etc., on glass. F. L. HILL. U. S. 1,924,787, Aug. 29, 1933.

Coating refractories with metal. J. D. MORGAN (Doherty Research Co.). U. S. 1,924,876, Aug. 29, 1933.

Cements

Sulfoaluminous cement. S. KLEIN. *Rev. mat. constr. trav. pub.*, No. 285, pp. 193–97 (1933).—Sulfoaluminous cements are slag cements to which 12 or 15% calcium sulfate and 1 or 2% free lime, as catalyzer, are added instead of fat or hydraulic lime. This modifies the composition of the water for mixing in such a manner that the intrinsic energy of the slag is liberated in several days instead of years. Because of the formation of the sulfoaluminate, a reaction takes place which helps considerably in the total hardening. Mechanical tests and the action of sulfated water are discussed. M.V.K.

Contribution to the study of the setting of cement. JULES CATIAUX. *Rev. mat. constr. trav. pub.*, No. 285, pp. 198–99 (1933).—Tests for determining the progress of the loss of water and that of the carbonic anhydride during the setting and hardening of cement are described. The setting occurs in 2 periods: (1) the whole cement mass thickens and shrinks, and (2) a slow and progressive crystallization takes place. It seems that a phenomenon similar to that observed during the liquefaction of alloys, crystallization in 2 periods, is produced during setting. M.V.K.

Addition of bitumen to cements. W. DYCKERHOFF. *Tonind.-Ztg.*, **57** [55], 637–39; [57], 660–62 (1933).—According to the original experiments, a certain quantity of bitumen is mixed with lime, and this mixture is ground together with cement and more lime. Better results are obtained by heating the bitumen and cement and vaporizing them. Both vapors will mix, and a thin layer of bitumen will form on the surface of each individual cement grain. This method will result in a large surface common to both the cement and the bitumen. The grain size distribution of the cement is not changed by the vaporization process. Experiments show that cements containing bitumen have a lower strength, higher tensile strength, and smaller increase of temperature during setting than ordinary cement. The most important fact, however, is the smaller shrinkage of bitumen-containing cement. Volume changes of bitumen-containing cements when subjected alternately to air and water are much smaller than those of ordinary cements. This is of a special value in the construction of concrete roads, etc. No open joints are necessary in roads built of bitumen-containing cement. W.M.C.

Free lime in Portland cement. G. E. BESSEY. *Jour. Soc. Chem. Ind.*, **52** [29], 219*T* (1933).—This paper deals with the importance of discriminating between free calcium oxide and hydroxide in cements and with the effect of these compounds on soundness. A simple method is given for determining the calcium hydroxide content of a cement. C.H.T.

Calcium silicate synthesis. I. SEIJI KONDO AND TOSHIYOSHI YAMAUCHI. *Jour. Soc. Chem. Ind.* [Japan], **36** [4], 167*B* (1933). M.V.K.

Synthesis of calcium silicates. V and VI. S. NAGAI AND K. MURAKAMI. *Jour. Soc. Chem. Ind.* [Japan], **36** [5], 264–68*B*; [6], 326–30*B* (1933); abstracted in *Rock Prod.*, **36** [7], 43 (1933).—By heating a mixture of pure calcium carbonate and silica to 1450°, pure tricalcium silica is easily produced. Tables and diagrams illustrate the discussion. For Part IV see *Ceram. Abs.*, **11** [8], 440 (1932). M.V.K.

Gypsum, origin and uses. JAMES H. TAYLOR. *Sands, Clays, & Minerals*, **1** [4], 42–45 (1933).—A discussion of the origin of gypsum, gypsum deposits, and its uses in industries is given. M.V.K.

BOOK

Chemistry of Cements. KARL E. DORSCH. *Z. Ver. deut. Ing.*, **77** [28], 780 (1933); for abstract see *Ceram. Abs.*, **12** [8], 292 (1933). L.T.B.

PATENT

Wet process and means for treating slurry in rotary kilns for cement, etc. G. COOYMANS. Brit. 396,265, Aug. 10, 1933.

Enamels

Summary of the observations and facts concerning the phenomenon of reboiling. J. O. LORD. *Jour. Amer. Ceram. Soc.*, **16** [9], 442–51 (1933).

A peculiarity of sheet-iron acid resisting cover coat enamels. H. E. EBRIGHT AND J. E. HANSEN. *Jour. Amer. Ceram. Soc.*, **16** [9], 433–36 (1933).

Progress report on the study of gases in enameling iron. R. W. BAKER AND J. C. JOUBLANC. *Jour. Amer. Ceram. Soc.*, **16** [9], 437–41 (1933).

Adherence of enamel to iron. R. ALDINGER. *Sprechsaal*, **66** [15], 251 (1933); *Emailwaren-Ind.*, **10** [18], 142–44 (1933).—An enamel piece chipped from an enameled object has a blackish layer whose presence is necessary for a good adherance as demonstrated by Cook. On a badly adhering ground enamel a blank silver sheet is seen. Melting can be divided into (1) oxidation of the iron surface, and (2) fusing of the oxide layer formed with the enamel. Between these a certain adherence is attained. Light ground enamels which tend to produce an adhering layer belong to this type and can be divided into 3 classes: (1) batches with large additions to the mill, (2) phosphate enamels, and (3) batches having adequate preparation of the sheet metal. In enamels of the first type, the dissolving power of the enamel for the iron oxide film is lowered through additions of quartz, kaolin, opacifiers, etc. The same action is reached with phosphates, and the adherence is better than in the first case. The best results are obtained with the third type. Most of the attempts deal with the oxidation of the iron surface, or thin coats of cobalt, nickel, copper, or other salts that are set up on the sheet metal. The best adhering layer is obtained when the ground enamel contains cobalt. The physical properties of the enamel are also important for the adherence. It can be increased by lowering stresses in the enamel as they produce flaws. The experiments of Meures and Zschimmer (see following abstract) showed that stresses working counter to the adherence can be lowered to such an extent that a ground enamel without an adhering oxide adheres solidly to the iron sheet with a slow cooling of the enameled object from about 200°C down, while with an ordinary cooling the enamel will crack after a short time. M.V.K.

Contribution to the explanation of the adherence of enamels to sheet steel. K. MEURES AND E. ZSCHIMMER. *Rev. belge ind. verrières, céram., émail.*, **3** [4], 80–82; [5], 101–104; [6], 130–33 (1932); for abstract see *Ceram. Abs.*, **11** [5], 293 (1932). P.E.C.

Asphalt spots in enameled cast-iron ware. HUGO SCHULZE. *Emailwaren-Ind.*, **10** [5], 34–36 (1933).—After having received a color or tar coating (the so-called asphalting), the cast iron of the finished enameled ware absorbs it in places. These faulty places appear as dark spots and small flaws occur in the enamel. These defects are due to a defective casting of the iron and may be overcome by careful supervision of the casting process and especially of the melting. M.V.K.

Possibilities of using silicate of soda in foundries for filling porous castings. ALBERT DEBECQ. *Rev. belge ind. verrières, céram., émail.*, **4** [5], 108 (1933).—In place of linseed oil as a filler for porous castings it is proposed to fill the pores with silicate of soda which is heated and applied to the metal under pressure. Details of design for the apparatus are given. The silicate of soda should have a Bé value of 38 to 40°, and SiO_2/Na_2O greater than 3.3. P.E.C.

Soda-ash blowholes in cast iron. S. A. R. PHELPS. *Foundry Trade Jour.*, **48**, 422 (1933).—A closer-grained metal was obtained, but blowholes appeared which were attributed to the introduction of the soda ash. H.H.S.

History of the industry of enameling articles made by casting and from sheet metals in Belgium. ANON. *Rev. belge ind. verrières, céram., émail.*, **3** [2], 29 (1932).—David Moll, a German, established the first plant in Belgium in 1838 at Charleroi. P.E.C.

Superheating cast iron in the electric forehearth. H. KALPERS. *Giesserei*, **20**, 7–8 (1933).—Fluid Fe from the cupola is heated in the electric forehearth to obtain a better cast structure, uniform distribution of graphite, and improved mechanical properties. At 1300 to 1400° fluid Fe contains undissolved graphite which is dissolved at 1500°. In an 8-hr. shift 12 tons of molten Fe from the cupola can be heated to 1580 to 1600° (180 to 200° superheat) in the electric forehearth with a current consumption of

only 60 kw.-hr. per ton. The average strength of the castings is 21.7 kg. per sq. mm. compared to 16.3 kg. per sq. mm. for castings made directly from cupola Fe. (*C.A.*)

Electric-furnace cast iron in the jobbing foundry. W. B. CRAWFORD AND R. B. CRAWFORD. *Iron Age*, **131**, 700 (1933).—Rocking the furnace and increasing the temperature of melt improved the properties of the cast iron. Flexibility of unit is discussed. (*C.A.*)

Pulverized coal for cast iron production. P. M. MACNAIR. *Fuel Econ.*, **8** [93], 544 (1933).—A serious rival to the cupola for the production of cast iron is the rotary furnace fired with powdered coal. The rate of heat liberation is of the order of 100,000 B.t.u. per cu. ft. of furnace volume per hour. The air is preheated in recuperators. The furnace consists of a cylindrical steel shell with cone-shaped ends, lined with high quality ground ganister mixed with about 10% of a siliceous clay bond which is tamped in place. The furnace is rotated at the rate of one revolution in $1^1/_2$ minutes. Excessive roof temperatures common in other smelting furnaces are avoided, and in addition there is no permanent slag line with attendant severe corrosion. W.E.R.

Fluorine determination in enamel. LÖFFLER. *Glashütte*, **63** [23], 391 (1933).—Attempts to determine fluorine in fluorspar, cryolite, and enamel are discussed. The usual methods do not permit an exact determination of fluorine. The treatment itself produces errors in the analysis. Thus, when treating fluorspar with soda, a part of CaF_2 is precipitated in crystalline form which is not dissolved by sulfuric acid and can not be converted. When treating the enamel with soda, fluorine compounds soluble in water are formed which can not be determined quantitatively. The best method proved to be the treatment of 0.5 g. enamel for 1 hr. at 500°C with 1 part soda and 1 part potassium nitrate. The loss in fluorine is small. M.V.K.

Cooling fired enamel. VIELHABER. *Emailwaren-Ind.*, **10** [15], 121–23 (1933).—After discussing the researches of Aldinger (see this issue, p. 355), V. states that flaws are due to rapid cooling and that the cooling itself is less important than the fact that the cooling of the whole enamel thickness proceeds irregularly. Glass and enamel are bad conductors of heat; their surfaces cool but their interiors remain warm for a long time. The surface contracts on cooling, but this contraction proceeds much slower in the inner parts, and stresses between the outer and inner layers occur. These, when exceeding the tensile strength, produce flaws. Hence, it can be inferred that the thicker the glass or the enamel, the more readily do stresses and flaws appear. M.V.K.

Measuring brightness of finished enamel. ERNST. *Glashütte*, **63** [23], 391 (1933).—A simple measuring apparatus (photoelectric cell) for the enamel industry is described. There is an aperture on the bottom of the apparatus on which a white enameled plate or object is laid. The absolute white content of the sample is measured in per cent on a small measuring instrument. A corresponding filter is inserted to determine the gray or yellow content of the opacified white enamel. M.V.K.

Electrical resistance of enamel. H. SALMANG AND F. HOLLER. *Sprechsaal*, **66** [28], 474 (1933).—A detailed account of researches made is given. Curves show the results for temperatures up to 600°, at which the enamel softens. The curves show that the specific resistance of the enamel increases with the increase in acid stability. Up to 400° it has such high values that all enamels investigated may be considered as insulators. M.V.K.

Decorating enamelware. FRANZ STIASNY. *Emailwaren-Ind.*, **10** [18], 145–46 (1933).—Details of decorating enamelware according to the Smetana method, consisting of a new contrivance permitting the employment of stensils for direct positive stamping of objects of different shapes, are given. M.V.K.

Notes on enameling. I. A. H. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 5–6 (1933).—A historical review of the craft, with a few general statements on the technology of enamels, comprises the first installment. II. *Ibid.*, **4** [2], 35–36 (1933).—The historical sketch of the development of enameling work in all countries is continued. Dates and brief statements cover the major high lights of the development, *e.g.*, it is stated that the first enameled stove made in America was manufactured at Joliet, Ill., in 1890. III. *Ibid.*, **4** [3], 61–63 (1933).—H. gives statistical figures covering the development of the sheet-steel enamel business in Belgium, together with the factors that brought this development into being. IV. *Ibid.*, **4** [4], 82–83 (1933).—Properties and kinds of metals used for the finer sorts of enameled ware are discussed. Limitations and advantages of the different metals are explained. V. *Ibid.*, **4** [5], 105–107 (1933).—Instructions are given for preparing the metals for fine enamel work. Complete directions are given for color combinations. P.E.C.

Elimination of peculiar porcelain enamel surface failures. ANON. *Amer. Enameler* **6** [4], 3–4 (1933).—A brief discussion of some peculiarities of porcelain enamels such as

muddy appearance, scumming or separation, haze of several types, "iridescent sheen," and their remedies is presented. E.J.V.

Recent developments in porcelain enameling. F. R. PORTER. *Chem. Bull.*, **20**, 143–46 (1933). (*C.A.*)

Enamel coating in the ornamental ware industry. L. CHALMERS. *Synthetic & Applied Finishes* [London], **3**, 153–55 (1933); *Emailwaren-Ind.*, **10** [17], 136–37 (1933).—Directions for enameling gold and gold alloys and for obtaining transparent and opaque gold enamels are given. M.V.K.

Physical considerations of white and variegated enamel colors. D'ANSS. *Glashütte*, **63** [23], 391 (1933).—To improve the appearance of enameled objects or to coat the darker ground enamel, the ware is provided with a white or colored enamel coat. The addition of a certain color can not alone improve the appearance of the object, but the colors added should harmonize (Ostwald's color table) to produce the best color effects. The physical bases of the origin of white, gray, and variegated colors are discussed on the basis of light-absorption curves. The degree of white opacification depends greatly on the opacifier employed and especially its refractive indices. The value of the degree of distribution of the opacifier is emphasized. The finer or the more dispersed the opacifier (which is added to the mill), the greater is the reflection of light and the better white opacification the finished product shows. Calculations of the surfaces of reflection of the opacifying particles intercalated coincide with the Lambert-Beerch law. M.V.K.

Phonolite as enamel raw material. ANON. *Glashütte*, **63** [25], 421–22; [26], 442–44 (1933).—Phonolite is a most suitable and easily fusible flux for different enamels. Although phonolite can not be used for white glazes, it can be employed for sheet metal ground enamels and colored enamels. The enamels obtained are easily fusible and cheap. Different enamel batches are given. Phonolite deposits and composition are discussed. M.V.K.

Poisonous quality of enamel and its raw materials. H. KARMAUS. *Emailwaren-Ind.*, **10** [8], 57–60 (1933).—A discussion of the poisonous effects of enameled objects is given. (1) Soda is considered to be harmless although disagreeable during mixing. (2) Sodium fluosilicate has the same effect. (3) Zinc oxide is nonpoisonous. (4) Barium carbonate is nonpoisonous except when used in large quantities. (5) Barium sulfate is absolutely nonpoisonous. (6) Feldspar and quartz in certain cases promote silicosis. (7) Lead poisoning is always chronic. Nickel, antimony, cobalt, and potassium may be poisonous although the enamel industry has never had cases of antimony or nickel diseases. M.V.K.

Rhenish pumice stone instead of feldspar. VIELHABER. *Emailwaren-Ind.*, **10** [17], 134–35 (1933).—Attempts to use pumice stone instead of feldspar in enameling are described. The pumice stone employed contained 0.57% SiO, 0.24% alumina, and 0.16% alkalis. The pumice enamel obtained had an opacity similar to that of feldspar enamel of the same composition but had a higher luster and was more gray because of manganese. The pumice enamel fused more easily and had a smoother surface. Although white enamels could not be obtained because of the presence of manganese in the pumice stone, all of the colored enamels and ground enamels obtained were of high quality. The pumice stone is washed and finely powdered. Because of its large volume, the powder is well distributed in the batch and the enamel melts much easier than that containing feldspar. Ten parts of feldspar in the batch correspond to 7 parts of pumice stone, 3 parts of quartz, and 0.3 soda. M.V.K.

Review of the latest technical development in enamel operation. H. J. KARMAUS. *Emailwaren-Ind.*, **10** [22], 173–76 (1933); abstracted in *Sprechsaal*, **66** [15], 250 (1933).—A new raw material known as Habera-potash feldspar, with a low iron oxide content, has been found in Thüringia. Experiments have been made to replace feldspar with a special kind of pumice stone (see preceding abstract). This is suitable only for ground and colored enamels because of its manganese content. Among different beryllium fluoride compounds found on the market, the sodium beryllium fluoride (formula $2NaF \cdot BeF_2 = Na_2Be_2F_4$) is the most suitable. It lowers considerably the melting point of the enamel. "Ultra-Sil," a new nonpoisonous colloid, can be used instead of clay in enamel. The suspending power of this product is exceptional. The known principle of opacity of Kreidel's gas opacifying has been improved. A new pickling supplementary agent, "Rostex Bz," produced good results. Other improvements with regard to the manufacture of enameling sheet metal and yellow coloring agents stable at high temperatures are described. The utilization of generator gas tar for firing, protection of refractories in muffles, and tunnel furnaces are mentioned. New patented methods for enameling bathtubs and wet enameling, in which the cooled object is put into a closed

space saturated with pulverized enamel mist which precipitates on the object, are described in detail. New application fields of enamels are mentioned. M.V.K.

Theoretical considerations on the opacity of enamel. L. STUCKERT. *Emailwaren-Ind.*, **10** [27], 213–20 (1933); abstracted in *Sprechsaal*, **66** [15], 251 (1933).—Calculations of a series of successive reflection surfaces with a perpendicularly falling light, but disregarding absorption, are given. The degree of approximation of these formulas with reality is satisfactory especially when the opacifier is pure white. Dark impurities or a technical gray content greatly lowers the intensity of the reflected light because of the repeatedly increased absorption. The quantitative measurements made heretofore of the strength of opacity have been few and do not permit comparisons with the results of the formulas discussed. It is necessary to make exact measurements of the opacity as a function of the particle size, thickness of the enamel coat, and concentration of the opacifier on uniformly dispersed enamels. Considerations of the physical factors for the evaluation of opacity require experimental testing. See also *Ceram. Abs.*, **12** [3], 94 (1933). M.V.K.

Porosity testing of enameled ware. W. DAWIHL. *Glashütte*, **63** [23], 391–92 (1933).—In porous enamel, a distinction should be made between a porosity produced by gas and porous places in the enamel produced by enamel defects such as bubbles, flaws, needle tappings, etc. To test the density or the absolute protection of the enamel coat for the metallic base, the following practical method is given: The outer surface of the object (the iron or metal) is connected with the pole of an electric conducting wire. The enameled part (inner surface) is filled with water containing common salt in which the other pole of the conducting wire is immersed. If the enamel coat is absolutely dense, the circuit is not closed. To determine qualitatively the conductivity of the enamel, an incandescent bulb can be included into the connected circuit; for a quantitative measurement, an ammeter should be connected. In the presence of pores or little flaws, the liquid penetrates to the metallic base and the circuit is closed. The results obtained with this method have been quite satisfactory in practice. M.V.K.

Relationship of theory and experience in industrial drying and processing. VIII. Drying and finishing in the refrigerator industry. C. F. MAYER. *Fuels & Fur.*, **11** [2], 64–66 (1933).—Typical drying oven equipment and vitreous enameling furnaces employed in the finishing of iceless refrigerators are discussed. Illustrated. For Part VII see *Ceram. Abs.*, **12** [2], 70 (1933). E.J.V.

Industrial electric heating. XVIII. Porcelain enameling. N. R. STANSEL AND L. C. ATHY. *Gen. Elec. Rev.*, **36** [4], 194–200 (1933).—The wet and dry processes of porcelain enameling are treated in detail with emphasis on the value of the electric furnace in firing the enamel. The properties of the enamel finish are discussed. Illustrated. **XIX. Porcelain enameling furnaces.** N. R. STANSEL AND K. E. KJOLSETH. *Ibid.*, **36** [6], 275–81 (1933).—The batch resistor furnace is described and compared with the continuous resistor furnace in regard to their application to porcelain enameling. The primary requirements for a furnace for firing porcelain enamels are (1) low temperature gradient, (2) uniform distribution of heat, (3) temperature regulation, and (4) clean atmosphere. Illustrated. For Parts XII–XIV see *Ceram. Abs.*, **10** [8], 592 (1931). R.H.H.P., JR.

Rotating melting furnaces. R. DEMBREVILLE. *Rev. fonderie moderne*, **27**, 99–105 (1933).—Construction details are given for rotary melting furnaces with oil and powdered coal used as fuel. (*C.A.*)

Development of annealing pot furnaces. MAASE. *Feuerfest*, **9** [5], 65–67 (1933).—A detailed discussion of different types of furnaces and their development is given. M.V.K.

Factors affecting furnace practice. R. J. SARJANT. *Trans. Ceram. Soc.* [Eng.], **32** [3], 113–40 (1933); for abstract see *Ceram. Abs.*, **12** [4], 168 (1933). C.H.T.

Machines in enamel work. ANON. *Rev. belge ind. verrières, céram., émail.*, **3** [3], 56–57 (1932).—A machine not using brushes gives enameled ware the appearance of various stones such as jasper, granite, and marble. It is claimed that types of marbles may be imitated. A machine for sharpening burning points is similar to an electric drill of the portable type. It has a suitable guide for keeping the proper angle and uses a small grinding wheel at the end of the shaft which replaces the drill. This shaft has a universa joint to facilitate maintenance of the proper angle on the points. P.E.C.

Enameling conveyer controlled by photoelectric relay. ANON. *Ceram. Age*, **22** [1], 21 (1933).—Illustrated. F.G.H.

Glass-lined steel equipment and its use. ANON. *Glass Ind.*, **14** [8], 86–87 (1933).—A brief historical and technical discussion of the work of the Pfaudler Co., Rochester, N. Y., in producing steel tanks with highly silicated glass enamel coatings fused into the

steel at high temperatures is presented. Various industries using this equipment are enumerated. Illustrated. E.J.V.

Achievement in porcelain enameled houses. ANON. *Enamelist*, **10** [10], 11–12 (1933).—A detailed description of the Armco-Ferro house at the World's Fair is given. See also *Ceram. Abs.*, **12** [6], 217 (1933). E.J.V.

Modern home uses porcelain enamel. ANON. *Enamelist*, **10** [10], 19–20 (1933); *Better Enameling*, **4** [7], 15 (1933); *Ceram. Ind.*, **21** [2], 94 (1933).—The Wheeling Corrugating Co., subsidiary of the Wheeling Steel Corp., Wheeling, W. Va., has announced a new type of steel house embodying prefabricated principles. The exterior surface will be coated with porcelain enamel. A detailed description is given. Illustrated. E.J.V.

Porcelain Enamel Parade. F. E. HODEK, JR. *Better Enameling*, **4** [7], 14 (1933).—A brief report of the Porcelain Enamel Parade of exhibitors and its activities at A Century of Progress is given. E.J.V.

Unusual exhibit at World's Fair. ANON. *Amer. Enameler*, **6** [4], 6–10 (1933).—A description is given of the methods used in producing the Republic Steel Corp. exhibit in the Porcelain Enamel Parade, wherein a reproduction of an oil painting in 32 distinct colors was produced in enamels on a sheet 54 x 60 in. Illustrated. E.J.V.

Then and now in enameling. H. W. C. MEHLING. *Ceram. Ind.*, **21** [2], 79–80 (1933).—M. comments on the progress made during the past ten years in enameling, showing how mechanization has reduced cost and improved the quality of products. E.J.V.

Growth of China's enameling industry. ANON. *Ceram. Age*, **22** [1], 15 (1933). F.G.H.

BOOK

Practical Microscopical Metallography. R. H. GREAVES AND H. WRIGHTON. 2d revised ed. D. Van Nostrand Co., Inc., New York, 1933. 256 pp. Price $6.00. Reviewed in *Ind. Eng. Chem.*, **25** [8], 948 (1933).—This valuable and practical work contains a good discussion of photomicrographic technique. F.G.H.

PATENTS

Enameled metal articles and method of producing them. L. R. SMITH. U. S. 1,919,136, July 18, 1933.

Wall-tile attachment. A. W. NELSON (Columbian Enameling & Stamping Co.). U. S. 1,922,214, Aug. 15, 1933.

Bathroom fixture. W. G. BAUCH (Bauch Porcelain Products Co.). U. S. 1,922,345, Aug. 15, 1933.

Method of de-enameling. JOSEPH JANOTA, JR. (Victor Chemical Works). U. S. 1,923,828, Aug. 22, 1933. The method of removing vitreous enamel from metal articles consists in immersing them at atmospheric pressure in a caustic soda solution of at least 30% strength, at a temperature as high as the boiling point of a 30% solution thereof, and for a time sufficient to remove the enamel.

Vitreous enamel composition and methods of making. C. J. KINZIE AND J. A. PLUNKETT (Titanium Alloy Mfg. Co.). U. S. 1,925,560, Sept. 5, 1933. The method of preparing a sodium titanium silicate composite comprises heating a mixture of titanium oxide and silica with a less quantity of soda ash to substantial decomposition of the compounds at a temperature between 850 and 1200°C until a fused glass is formed in which the compounds are chemically recombined.

Process of producing enameled articles having a multicolored appearance. PORCELAIN ENAMEL & MANUFACTURING CO. OF BALTIMORE. Brit. 395,482, July 26, 1933.

Production of white opaque enamels. I. KREIDL. Brit. 396,007, Aug. 2, 1933.

Glass, enamels, etc. TH. GOLDSCHMIDT A.-G. Fr. 742,360, March 6, 1933. In making glass, glazes, enamels, etc., silicates of Pb, double silicates of Pb and Na or K, or solid solutions of silicates of Na and K with silicates of Pb are used instead of minium or litharge. The Pb silicate is preferably made from a fused Pb oxide. (*C.A.*)

Enameling metal. ERNST HEENE. Fr. 743,758, April 6, 1933. Cu and Cu alloys are given an intensive treatment with acid and then coated with an enamel free from products capable of tarnishing, *e.g.*, one containing SiO_2 45.5, K_2O 8, Na_2O 14, Ba_2O_3 19.5, Al_2O_3 6.5, and CaF_2 6.5. The enamel is applied directly by pulverization and the objects are fired at a temperature (800°) at which all the constituents of the enamel melt to form a limpid covering. (*C.A.*)

Household articles of copper or its alloys coated with transparent glaze. ERNST HEENE. Ger. 569,095, Dec. 15, 1931; see preceding patent. (*C.A.*)

Enameled copper plates, etc. ERNST HEENE. Ger. 575,382, April 27, 1933. A few additional details of the method of Ger. 569,095 are given. (*C.A.*)

Grate for enameling kiln. METALL-INDUSTRIE METTMANN J. KLEFISCH. Ger. 574,318, April 12, 1933. (*C.A.*)

Glass

Gases in glass. R. H. DALTON. *Jour. Amer. Ceram. Soc.*, **16** [9], 425–32 (1933).

Phase-equilibrium relationships determining glass compositions. G. W. MOREY. *Ind. Eng. Chem.*, **25** [7], 742–48 (1933).—Glasses are undercooled liquids, the term "liquid" having the technical meaning used in phase-equilibrium work. Glasses pass from the thin molten condition during their manufacture through a continuously changing sequence of properties to a hard, brittle substance of sufficient strength and rigidity to be of value in technology. Glass has been known to mankind from the earliest times, and the oldest glasses do not differ greatly in composition from most of the glassware today. This is because the particular properties required of a practical glass composition make it necessary that it be not greatly different in composition from the ternary eutectic between the compounds $Na_2O{\cdot}2SiO_2$, $Na_2O{\cdot}3CaO{\cdot}6SiO_2$, and quartz in the ternary system Na_2O–CaO–SiO_2. Only when of such a composition is it both fluid enough at easily attainable temperatures to be readily melted on a commercial scale and viscous enough at its freezing point so that devitrification is inhibited. The relation of various complex glasses to this simple eutectic glass is discussed. While there is extensive knowledge of glass composition practically nothing is known about its constitution. Illustrated with diagrams and sketches. F.G.H.

Critical temperatures in silicate glasses. J. T. LITTLETON. *Ind. Eng. Chem.*, **25** [7], 748–55 (1933).—There are no critical temperatures in the properties of glasses. There is a change of some sort, possibly in degree of dissociation, or a molecular aggregation which occurs at all temperatures until a stabilization has taken place. This change is resisted by the viscosity of the glass. At low temperatures the retardation is so great that the change is never measurable in finite times; at intermediate temperatures it is observable, and at high temperatures it is sufficiently rapid so as to completely follow the temperature. The changes in expansion coefficient, specific gravity, electrical conductivity, and heat absorption or specific heat are changes in the properties of the material attending these changes in state. At or around the annealing temperature the glass is sufficiently fluid for these changes to be observable during the course of the measurements if the rates of temperature change are rapid. If, however, the rate of temperature change is slow enough so that at all times the glass is in a state of equilibrium, there would be no apparent discontinuities in the data but only a gradual change as the equilibrium condition of the glass changes. The question as to what this change in condition, dissociation, or molecular aggregation may be is still unanswered. Illustrated with numerous curves. See also *Ceram. Abs.*, **12** [2], 49 (1933). F.G.H.

Chemical composition of commercial glasses. D. E. SHARP. *Ind. Eng. Chem.*, **25** [7], 755–64 (1933).—The ranges of composition of a wide variety of modern commercial glasses are given, and reasons why compositions have been gradually altered from those in use some years ago are pointed out. Analyses of many of the glasses are included, and colored glass, technical glass, and optical glass compositions are treated briefly. Illustrated with curves and diagrams. F.G.H.

Chemical analysis of glass. G. E. F. LUNDELL. *Ind. Eng. Chem.*, **25** [8], 853–56 (1933).—Glass is sold on physical rather than chemical requirements, and the needs for analyses are those connected with the control of manufacturing operations, duplication of glasses, and researches. The methods of analysis employed are not very different from those used in early days, although the development of new types of glasses and the adoption of revolutionary methods of manufacture have necessitated certain changes. Modifications of the old methods which have been developed and a few new procedures which are beginning to be used to some extent are briefly discussed. The accuracy of the results that are obtained in present-day methods of analysis is considered. More exacting demands will no doubt be made in the future, not only with regard to speed, completeness, and accuracy of analyses, but also to determinations of constituents that occur in exceedingly small amounts and to the states in which some of the constituents occur. F.G.H.

Methods of melting glass. S. R. SCHOLES. *Ind. Eng. Chem.*, **25** [8], 870–72 (1933).—Modern furnaces, classified as pot and tank furnaces, are described in regard to

design, efficiencies, application to ware made, merits, and defects. Recent developments and improvements are discussed. Temperatures and their measurement are treated from the standpoints of effectiveness and control. The melting mechanism is discussed with a description of the behavior of the batch ingredients and their fusion into the clear homogeneous silicate solution, the ideal glass. F.G.H.

Viscosity of optical glass. W. H. WADLEIGH. Bur. Stand. *Jour. Research*, **11** [1], 65–78 (1933); R.P. 577.—This paper reports an investigation of viscosities, at elevated temperatures, of six optical glasses: light barium crown, borosilicate crown, soda-lime, and dense, medium, and barium flints. Searle's modification of Margule's concentric cylinder type viscometer was adopted. The paper contains a description of the furnace, crucible and stirrers, driving mechanism, and timing and temperature-measuring equipment of the complete set-up. The classical equation for viscosity was modified to adapt it to the apparatus. A fairly detailed description is given of the evaluation of certain factors and corrections such as production of constant speed, friction, "end effect," and relation of effective load to r.p.m. It was necessary to establish these evaluations prior to actual tests on the glasses. Further carefully made adjustments and measurements, such as the determination of the "wetted height" or depth of immersion of the stirrer in the glass, are necessary after the glass has been introduced into the apparatus and raised to the temperature of test. The results of 255 viscosity tests on a total of 50 samples of the 6 optical glasses are summarized in equations expressing the mathematical relations of viscosity to temperature. Because of volatilization as well as partial solution of crucibles and stirrers by several glasses, especially borosilicate crown, the exact compositions of the glasses at the time of test are not known. An approximation of the importance of volatilization and solution as factors in viscosity determinations was obtained by a number of tests of the borosilicate crown glass in a crucible of special and more resistant porcelain with the crucible and stirrer protected with platinum. As a result of the investigation of the many factors involved in making viscosity determinations at high temperatures with the concentric cylinder type viscometer, it is believed that the information obtained permits the investigator to so evaluate and apply the necessary corrections as to make possible the obtaining of additional viscosity values of significant accuracy in so far as the apparatus itself is concerned. It has been shown further that the solution of the crucible and stirrer by the glass and volatilization of the glass are factors of major importance because they may materially alter the composition of the glass during the course of a test. It should be a relatively simple matter to avoid contamination of the glass by solution of the container, but this is not true of changes due to volatilization. However, volatilization could be greatly minimized. R.A.H.

Alterability of glass. A. THÜRMER. *Rev. belge ind. verrières, céram., émail.*, **4** [5], 98–100 (1933).—T. gives the Deutsche Glastechnische Gesellschaft methods for testing glass for alterability. This method accounts for differences in glasses of different compositions but not for differences in glasses of the same composition made by different processes of fabrication. He lists four glasses of very close composition, made by Fourcault, pressing, blowing, and machine blowing processes, respectively, and with great differences in the solubilities. By coloring the surface of the specimen before crushing and screening he was able to study particles from the interior and from the surface in each case. His summary is as follows: (1) Previous heat treatments influence the final physical character of the glass. (2) Chemical attack depends very much on the steps of manufacture. (3) Chemical attack does not depend solely on chemical composition. (4) All glasses do not resist hydrolysis in like ways. (5) It would be well to classify glasses by their methods of manufacture and their ultimate uses in setting standards for alterability tests. P.E.C.

Changes appearing in pot and tank glass because of the dissolving of refractory materials. ANON. *Glashütte*, **63** [11], 185–88 (1933); abstracted in *Glastech. Ber.*, **11** [4], 150 (1933).—The defects appearing in the nature of molten glass in consequence of a reaction between the refractories and glass melts can be classified into two groups, (1) those that appear during melting and are permanent (inhomogeneity), and (2) those that appear occasionally in the pot or tank. On the basis of systematic researches of the dissolving of alumina by the glass in pots or tanks, it has been found that the dissolving of the refractory material is larger in tanks than in pots independent of the material of the melting vessel or of the glass. The mixing is much better in tanks, and therefore melting in pots has a greater danger of permanent defects. On the other hand, the periodic change in solubility is greater in tanks thus producing occasionally greater defects. The influence of quotients SiO_2:Al_2O_3 was not ascertained because the investigations were made on approximately similar batches and similarly composed

refractories. Pronounced defects in glass melts due to refractories or pot material, stones and streaks, result from an oversaturation in dissolved materials. M.V.K.

Effect of gases upon the properties of glass. I–III. K. NAKANISHI. *Jour. Soc. Chem. Ind.* [Japan], **36** [2], 76–78*B* (1933).—N. made the following conclusions: (1) Soda-lime glass develops gases when heated up to its softening temperature and the higher the temperature the more gas is developed. At the softening temperature the glass absorbs gas from the surrounding atmosphere. (2) Soda-lime and soda-lead glasses also develop gases. The gas-absorbing property of potash glass is superior to that of soda glass. (3) Soda-lime and soda-lead glasses absorb N_2 and CO_2 when heated in these gases, although much less than when heated in O_2. The gas-absorbing property of glass rich in alkalis is superior to that of one poor in alkalis. Glass rich in alkalis shows a noticeable increase in weight when heated above its softening point because of its gas-absorbing property. **IV.** *Ibid.*, **36** [6], 330*B* (1933).—The stability of glass treated at 115 to 120° in air, nitrogen, and vacuum was studied. It was found that the chemical stability improved when the glass was heated to 115 or 120° in air. The stability of the glass was restricted to its surface only and the inner part was not changed. Heating in a vacuum was more effective when the temperature was not too high; when the temperature was too high, the surface of the glass dulled and the stability was lowered. Heating in nitrogen improved the stability. N. concludes that the improvement of the stability of glass treated to a temperature below its softening point is not caused by a chemical change in the glass or by formation of some stable substances on its surface because of the surrounding gas, but is due to the development of gases adsorbed on the glass surface or absorbed by it. M.V.K.

Influence of annealing on the determination of the coefficient of expansion of glass by means of the gravimetric thermometer. B. KOROLEV. *Keram. i Steklo*, **9** [4], 27–28 (1933).—A detailed account of researches made to determine the effect of annealing on the determination of the coefficient of expansion of glass is given. The investigations of Tool, Lloyd, and Merritt (*Ceram. Abs.*, **9** [10], 829 (1930)) on the dimensional changes caused in glass by heating cycles are discussed. M.V.K.

Influence of alumina on the fusibility of glasses. F. SINGER. *Keram. Rund.*, 1915; *Rev. belge ind. verrières, céram., émail.*, **3** [5], 104–106; [7], 154–55 (1932). P.E.C.

Two members of the family of glasses: chemical glass and optical glass. P. GILARD. *Rev. universelle mines*, **76** [9], 243–48; [10], 268–72 (1933).—G. discusses some of the problems encountered in the manufacture of glasses. The physical and chemical state of glass is briefly reviewed. The requirements of glassware for chemical and optical purposes are pointed out and the differences in these requirements are stressed. L.T.B.

Notes on the manufacture of colorless glasses. ANON. *Glass*, **10** [7], 272–75 (1933).—This is one of a series of articles in which general imperfections such as (1) batch stones, (2) refractory stones, (3) salt water and sulfate stones, and (4) slight cloudiness are discussed. *Ibid.*, **10** [8], 316 (1933).—Elimination of seed, control of color and brightness, effect of special ingredients on color and rate of fining, homogeneity, devitrification and stones, and general imperfections are discussed. C.H.T.

Separation of homogeneous glass masses. ALFRED THÜRMER. *Ceram. Ind.*, **21** [2], 76–78 (1933).—A series of well-known faults in glasses is traced back to the separation of homogeneous glass masses. It is shown that separation in homogeneous glass melts during the working process is possible under appropriate conditions. Many conditions which facilitate separation are necessary for the working process but, on the other hand, there are ways and means to preserve the homogeneity of the finished glass melt: (*a*) The batch should be completely homogeneous and the melting conditions, firing, temperature, glass flow, etc., should have a neutral effect. (*b*) After the fining the glass should not stand longer than absolutely necessary (in not too large a working chamber). (*c*) Temperature increases and repeated heating of the finished glass melt are detrimental. (*d*) Glass approaching the working point or glass which is about to be worked must not be cooled down below the working temperature and must under no circumstances be cooled down to the temperature at which spontaneous crystallization may take place. (*e*) Stagnant glass masses should be avoided by proper insulation or, at least, they should be prevented from increasing by influencing the glass flow. E.J.V.

Source of striations according to Emile Fourcault. R. R. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 6 (1933).—The article covers Fourcault's idea of the pulsating flow of the glass to avoid striations, quotes his statements on the subject, and names the terms of his patent covering the idea. P.E.C.

Cracking of glass. LEOPOLD RIEDEL. *Glas & Schmuck*, **4** [1], 1–3 (1933); abstracted in *Glastech. Ber.*, **11** [3], 105 (1933).—R. discusses the reasons and effects of tensions in glass and their avoidance through appropriate cooling. M.V.K.

Refining glass from bubbles. V. VOANO. *Keram. i Steklo*, **9** [5], 24–25 (1933).—Causes for the formation of bubbles in glass are described. The development of gases in dependence on temperature, pressure, and composition of the glass is discussed. M.V.K.

Seeds and cords in glass. I and II. M. PARKIN. *Glass Rev.*, **9** [4], 54–55; [5], 67–70 (1933); see also article by Jebsen-Marwedel, *Ceram. Abs.*, **11** [10], 520 (1932). A.A.

Some recent work on the devitrification of lead crystal glass. M. PARKIN. *Glass Rev.*, **9** [6], 80–83 (1933).—In this connection the work of W. Hirsch (*Ceram. Abs.*, **12** [5], 185 (1933)) is discussed. A.A.

Cause of danger of an explosion in the silvering of glass. E. LOHMANN. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 15 (1933); for abstract see *Ceram. Abs.*, **12** [2], 54 (1933). P.E.C.

Manufacture of Frenel lenses in U.S.S.R. I. I. KITAIGORODSKII. *Keram. i Steklo*, **9** [4], 3–8 (1933).—A detailed account of attempts made to produce colored and colorless Frenel lenses by the Glass Institute is given. Conditions at which selenium ruby with a definite index of refraction is obtained in open glassmelting pots were determined. Conclusions were as follows: (1) The introduction of potassium oxide into the batch is not necessary for obtaining red lenses. The viscosity of the glass melt is the essential condition. (2) For obtaining a definite intensity of the red color, 0.1% selenium is sufficient. The volatility of selenium amounts to about 70 to 90%. (3) The melting time and melting conditions have a considerable influence. (4) A reducing atmosphere is necessary in the first period of melting. Depending on the way in which the colorizer (metallic selenite or selenates) is introduced and on the course and direction of the reaction toward reducing or oxidizing, the reducing and oxidizing conditions must vary at the beginning of the melting. (5) Satisfactory results were obtained with metallic selenium, although more stable results were obtained with cadmium selenide or a mixture of selenium and metallic zinc. A completely colorless glass was obtained when saltpeter was added to the red glass batch. Molds for pressing and conditions of pressing Frenel lenses are also discussed. M.V.K.

Manufacture of Frenel lenses at the 3KDO glassworks. N. D. ZAV'YALOV AND G. M. MINKIN. *Keram. i Steklo*, **9** [4], 8–11 (1933).—A detailed description of experiments on the manufacture of colored and colorless glasses for Frenel lenses is given with technological particulars of their production. M.V.K.

Constitution of glass. II. WOLDEMAR WEYL AND EVA THÜMEN. *Glastech. Ber.*, **11** [4], 113–20 (1933).—On the basis of examples, it is shown how it is possible to obtain an insight into the nature of glass coloring from exact absorption measurements in the visible range. It is possible to ascertain quantitatively the oxidation equilibriums in manganese and chromium glasses and to study the dissociation and association equilibriums between nickel and cobalt silicates and silica as solvent. It has been found that a far-reaching analogy exists between glasses and solutions. For Part I see *Ceram. Abs.*, **12** [5], 184 (1933). M.V.K.

Researches on the coloration of glass by cementation. Yellow from silver. A. LECRENIER, P. GILARD, AND L. DUBRUL. *Rev. belge ind. verrières, céram., émail.*, **4** [3], 51–57 (1933).—The authors state that glass composition, composition of the cementation mixture, temperature of the heating treatment, and the furnace atmosphere are all factors in the operations. The history of the process is sketched. Tabulated and briefly described experiments present the work done by the authors in covering the whole field. A not very successful trial was made with a developed photograph plate. A review of the various theories of other experimenters is presented. The theory is presented that silver ions penetrate the glass and replace potassium or sodium ions, and that the reducible substances in the glass free the metals from combinations. Coagulation of the silver into colloidal particles develops a coloration which depends on the size of the particles so developed. P.E.C.

Physicochemical principles of color decoration of glass. I. JACQUES WOLF. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 13–14 (1933).—W. discusses transparent glass, transparent glass with color in it, and more or less opaque glass briefly. **II.** *Ibid.*, **4** [4], 84–85 (1933).—W. discusses red and yellow coloration by cementation processes. The yellow comes from silver and the red from copper. Auxiliary materials for the production of these colors are discussed and various opinions of others are stated to explain the effects. The character of the glass itself is highly important. Chemical

resistance of the glass is generally improved by the process. See also book review, *Ceram. Abs.*, **12** [4], 150 (1933). P.E.C.

Copper ruby glass. R. D. *Rev. belge ind. verrières, céram., émail.*, **3** [9], 198–99 (1932).—A general statement is presented with type recipes for making copper ruby glasses. Directions for heat treatments are given. P.E.C.

Alkali vapor coloration in glasses and various compounds. JOSEF HOFFMANN. *Z. anorg. allgem. Chem.*, **211** [3], 272–76 (1933); for abstract see *Ceram. Abs.*, **12** [7], 257 (1933). L.T.B.

Ferrite and ferrite coloring of glasses. JOSEF HOFFMANN. *Sprechsaal*, **66** [28], 471–74 (1933).—The relationship between brown exposed pigments and alkaline metal vapor coloring of silicate glasses with alkali metal absorptions and alkali ferrites is discussed. See also preceding abstract. M.V.K.

Temperature dependence of silver migration in glasses. MARTIN RICHTER. *Glastech. Ber.*, **11** [4], 123–28 (1933).—The temperature dependence of pure silver halide melts in glasses of different compositions was investigated in the temperature range from 270 to 610°C. The melts form equilibriums with the glasses which always lie more on the side of the melt. The migration experiments always show a linear relationship between the logarithm of the depth of penetration of the coloring zone and the reciprocal absolute temperature for the brittle and for the viscous glass state. M.V.K.

Alkali beryllium borate glasses transmitting ultra-violet radiation. W. ZIEGLER AND M. WELLMANN. *Z. tech. Physik*, **14** [7], 288–89 (1933).—A glass was investigated of the composition 82% B_2O_3, 13.6% Li_2O, 4.4% BeO. This glass will transmit not only soft X-rays but also ultra-violet light. The best manufacturing temperature for this glass is 950°C. This glass is more durable than the so-called Lindemann glass used in many X-ray tubes. The new glass may be sealed to ordinary glass. A number of spectra demonstrates that the new glass transmits almost as far in the short-wave region of the spectrum as quartz. It may be used, therefore, to replace quartz lens, etc. The transmission of the new glass is comparable to that of Corex glass. Irradiating the new glass by means of a mercury arc will not change its color or transmissibility. The glass may be colored for experiments in a small range of the spectrum. Instead of lithium, the less expensive sodium and potassium may be used in manufacturing this type of glass. W.M.C.

Ultra-violet rays of the sun and the stability of permeable glasses. ANON. *Glaces et Verres*, **6** [33], 12–13 (1933).—Experiments made by the French Optical Inst. on plate glass, "Sanitalit," with regard to the stability of its transparency to ultra-violet rays are discussed. Curves show the results. See also *Ceram. Abs.*, **12** [6], 219 (1933). M.V.K.

New glass protection from infra-red radiation. E. H. HOBBIE. *Nat. Glass Budget*, **49** [18], 16 (1933).—A glass designed to fulfill the requirements for protection from infra-red radiation is described. C.H.T.

Dark heat and luminous heat. Protection of dwellings against sun heat by "athermic glass." J. LE BRAZ. *Glaces et Verres*, **6** [33], 2–6 (1933).—B. discusses the difference between caloric and luminous rays. Attempts to manufacture glass permeable to luminous rays and impermeable to calorific rays have resulted in "Katathermic glass." This is a highly transparent glass of a bluish tint; it is completely opaque to infra-red rays and gives good protection against radiating heat. These properties are shown on curves. Experiments show that dwellings with such a glass have a temperature from 10 to 12° lower than that of the outside. M.V.K.

Transparency of glass. P. GILARD. *Rev. belge ind. verrières, céram., émail.*, **3** [3], 50–53; [4], 74–76 (1932).—G. discusses the physics of radiations in general and how they are affected by the media through which they pass. The usual formulas are quoted. Transparency is defined as nonabsorption of the radiations and the various ingredients are discussed concerning their effect on transparency in glasses used for different purposes and different kinds of radiations. Authorities are quoted freely. P.E.C.

Measurements of properties of light-diffusing hollow bodies. W. ARNDT. *Glastech Ber.*, **11** [4], 132 (1933).—A. discusses the results of testing methods used to determine the properties of light-diffusing hollow bodies. M.V.K.

Diffusing glasses for illumination. H. H. BLAU. *Ind. Eng. Chem.*, **25** [8], 848–53 (1933).—Recent developments in light-diffusing glasses of the spontaneous and controlled types are described. Glasses which diffuse the light by means of their internal structures (inclusions within the glasses) have outstanding illuminating advantages over those which diffuse light as a result of surface irregularities. Theoretical and empirical studies show that the properties of internally diffusing glasses may be largely controlled

by fixing the size, number, and character of the inclusions. Composition and thermal history determine these factors in glasses in which the inclusions are certain types of crystallites. Spontaneous crystallization during cooling accounts for the light diffusion in many of these glasses, but unusual illuminating properties can be obtained by controlled crystallization resulting from definite time-temperature schedules. Illustrations, curves, and sketches are included. F.G.H.

Work of the Commission for Illuminating Glass. L. BLOCH. *Glastech. Ber.*, **11** [4], 129–31 (1933).—A report of the work done in 1931 dealing with properties of light-diffusing hollow bodies and measurements of permeability, reflection, absorption, and effectiveness are given. M.V.K.

Replacement of window glass in vehicles by other materials. O. KAUSCH. *Kunststoffe*, **23**, 10–12 (1933).—The chief requirements of glass substitutes for vehicles are transparency, age stability, elasticity, absence of sharp points and edges and glass-powder formation on shattering, freedom of fractures from each other, sufficient hardness to resist impacts of small solid bodies, and resistance to weathering. In the first place compound glass is considered as a substitute for window glass. Celluloid and cellulose acetate are used as adhesives in compound glass. Hard glass used for Bologna flasks has recently come into use for windows. By quenching, a tension is produced in the glass which is responsible for decomposition on impact into pieces of the size of a pea. Celluloid alone is also used, but on account of inflammability and discoloration it is being substituted by (1) cellon, prepared from cellulose acetate by means of camphor substitutes, (2) cellophane, which is cellulose treated with CS_2, or (3) pollopas, a urea-formaldehyde product condensed with alkaline agents; the latter gives no sharp edges, is completely transparent, and sufficiently flexible. J.G.T.

New type of safety glass. ANON. *Ind. chimique*, **20** [232], 386 (1933).—Attempts to replace the intermediate layer of cellulose in triple safety glasses by a product superior in regard to resistance to atmospheric agents and light are discussed. Cellulose acetate is highly resistant to ultra-violet rays but adheres poorly to glass. Satisfactory results were obtained when using synthetic resins obtained by polymerizing some organic compounds as crotonate and acrilate of ethyl. The safety glass known as "Lugas" contains an intermediary layer of this type. M.V.K.

Raw materials for the manufacture of safety glass and its testing. FRITZ OHL. *Sprechsaal*, **66** [25], 422–24 (1933).—Data on the properties and requirements of the intermediate layer, glass, and other materials employed in the manufacture of safety glass are given. M.V.K.

"Armourplate" glass. ANON. *Nat. Glass Budget*, **49** [13], 16 (1933).—The method of manufacture and various tests are described. See also *Ceram. Abs.*, **12** [5], 186 (1933). C.H.T.

Character, significance, and requirements for safety glass. IV. C. H. ZEFER. *Glashütte*, **63** [13], 219–22; [19], 321–23; [20], 340–42; [34], 563–67 (1933).—A detailed discussion of (1) polymerization products, (2) wire glass, (3) fields of application of safety glass, and (4) their classification is given. For Part III see *Ceram. Abs.*, **12** [8], 294 (1933). M.V.K.

X-ray study of opals, silica glass, and silica gel. I. LEVIN AND EMIL OTT. *Z. Krist.*, **85** [3–4], 305–18 (1933).—For the first time the presence of crystalline material (other than quartz) in opals was demonstrated by the X-ray powder method. For most cases the crystals present correspond to high-temperature cristobalite (the lattice constant of which is $a_0 = 7.078$ Å at room temperature). This modification of silica has not previously been observed to occur in any natural material at room temperature. Its presence under corresponding conditions in certain artificial glasses, however, has been reported by others on the basis of optical examinations. Other modifications of silica present in certain opals are low-temperature cristobalite and quartz. The diffraction patterns of silica glass and certain silica gels are also discussed. G.R.S.

Notes on the phenomena of the opalization of glass. L. F. *Rev. belge ind. verrières, céram., émail.*, **4** [2], 26–29; [3], 57–58; [4], 77–78 (1933).—A thorough review of the literature is presented. All known opacifiers are listed and their effects and properties noted. Disputed points are presented and their various authors are named. Comment is made on the effects of heat treatment and tabulated material presents numerous formulas for the production of opal glasses. A bibliography concludes the article. P.E.C.

Influence of small amounts of dissolved silicates on the conductance of conductivity water and very dilute solutions of electrolytes. T. I. TAYLOR. *Jour. Phys. Chem.*, **37** [6], 765–77 (1933).—Measurements of the effects of small amounts of sodium silicate, such as are dissolved from glass, on the conductance of conductivity water of different

initial conductivities and on very dilute solutions of electrolytes were made. The change in the nature of impurities in conductivity water with different methods of collection and time of storage in Pyrex brand glass and soft glass containers was demonstrated. A correction for the "solution of glass" will depend upon the kind of glass used in storage, measurements of the conductivity water and the solutions, time of storage and measurement, and the nature of the electrolyte. G.R.S.

Phosphorescence of glasses. ALFONS SCHLOEMER. *Glastech. Ber.*, **11** [4], 128–29 (1933).—The existence of the phosphorescence of glasses is still denied by some investigators. The phosphorescence of vitreous materials, however, could be observed in some experiments. The solvation theory was utilized by S. because the constitution of vitreous phosphorus does not exactly agree with the conception of the lattice structure. M.V.K.

Solubility of R_2O–B_2O_3–SiO_2 glasses in water. KOZO TABATA AND TARO MORIYA. *Jour. Soc. Chem. Ind.* [Japan], **36** [2], 70–72*B* (1933).—The results are given in tables. M.V.K.

Relative volatilities of soda, potash, and lead oxide from molten glasses. ANON. *Glass Rev.*, **9** [3], 41–44 (1933).—The work done in this connection at the Dept. of Glass Technology at Sheffield is briefly reviewed. A.A.

Structure of glasses. W. H. ZACHARIASEN. *Glastech. Ber.*, **11** [4], 120–23 (1933); for abstract see *Ceram. Abs.*, **12** [4], 145 (1933). M.V.K.

Good quality bottles from poor sands (with a pinch of salt). M. PARKIN. *Glass Rev.*, **9** [4], 52–53 (1933).—The recently published paper by E. Damour and A. Nadel (*Ceram. Abs.*, **12** [6], 218 (1933)) is described. A.A.

Requirements of manganese in the glass industry. ANON. *Glass Rev.*, **9** [2], 18–19 (1933).—In view of the importance of pyrolusite for the glass industry, it is suggested that some specification be set up for this material. A.A.

Influence of the characteristics and treatment of the raw material on the properties of fused silica products, and the effect of treatment of the fused products on their properties. BURROWS MOORE. *Trans. Ceram. Soc.* [Eng.], **32** [2], 45–63 (1933); for abstract see *Ceram. Abs.*, **12** [1], 20 (1933). C.H.T.

Prolongment of the fusion in a pot furnace. ANON. *Rev. belge ind. verrières, céram., émail.*, **3** [2], 30–31 (1932).—A graph is given showing by temperatures and hours the proper treatment of a glass used for ordinary tumblers. Explanations follow covering each step indicated in the graph. The different steps are shown by a second set of section drawings of pots which have the metal conditions indicated conventionally. P.E.C.

Utilizing waste glass. ALEXANDER NADEL. *Glashütte*, **63** [23], 389–90 (1933).—Investigations show that when adding from 1 to 70% cullet, the composition of which corresponds exactly to the batch, to the glass melt no differences appear in the physical properties of the new and old glasses. However, it is very different when the cullet does not correspond to the batch. M.V.K.

"Glass is a salt." F. W. PRESTON. *Glass Ind.*, **14** [8], 85 (1933).—The statement that "glass is a salt" is discussed. It is pointed out that the word "salt" is a chemical term, and, as glass can not be defined in chemical terms, this statement is erroneous. E.J.V.

Economy and capacity of glass tanks. Effect of flame luminosity and other variables. W. TRINKS. *Ind. Eng. Chem.*, **25** [8], 865–70 (1933).—From a study of the heat balance of glass tanks it is concluded that with present-day refractories the most promising means of reducing fuel cost per unit of glass lies in increasing the rate of production of the tank. To this end, operators have made use of luminous flames because experience has shown that with such flames heat penetrates more deeply into the glass. The reasons for this effect are sought in the interaction of flame-and-cap radiation. Figures are given on the resulting increase in production. Designs of burners and ports for producing luminous flames are discussed. The effect of floaters, the shortcomings of the commonly used refractories, and the effect of insulation are touched upon. Improvements in the feeding of the raw materials and other methods of hastening refining, such as mechanical stirring of the glass batch, are pointed out as possible future developments. The cracking of gas, luminosity of flame, and penetration of radiant heat into glass are treated mathematically. Illustrated with diagrams and curves. F.G.H.

Electrical fusion of glass. LÉON FRANCQ. *Rev. belge ind. verrières, céram., émail.*, **3** [7], 151–53; [8], 175–80 (1932).—F. discusses briefly arc, indirect-resistance, direct-resistance, and induction type furnaces in general. Going into detail, he discusses four types of Becker, two types of Voelker, three types of Bronn, and one each of Gabreau, Birkeland, Eyde, Luhne, and Styzinski-Eusskirchen types of arc furnaces. Objections

to arc furnaces are stated. One type of Reich, two types of Bronn, three types of Sauvageon, two types of Readers, and one type each of Cornelius and Hitner are discussed in the resistance furnace class. Details of tests are given by Pilkington Brothers and British Hartford-Fairmont Corp. of a Cornelius furnace at Saint Helens (Lancastershire). This is a résumé from *Jour. Soc. Glass Tech.*, **15** [60], 338–44 (1931). He discusses briefly a general scheme for an induction furnace. All types of furnaces are illustrated by section drawings. Opinions about electric furnaces are unsettled. A bibliography is submitted. P.E.C.

New ideas and methods for melting glass. III. S. S. BERMAN. *Keram. i Steklo*, **9** [5], 12–16 (1933).—Different patented furnaces for melting glass are described. For Part II see *Ceram. Abs.*, **12** [9], 326 (1933). M.V.K.

Practical data for the construction of tank furnaces for melting glass. B. F. KUZMIN. *Keram. i Steklo*, **9** [5], 17–20 (1933).—A description of the construction of tank furnaces in U.S.S.R. is given. M.V.K.

Electromelting of glass. II. Reaction temperature of zinc oxide and amorphous carbon or artificial graphite. SEIJI KONDO AND CHIHIRO KAWASHIMA. *Jour. Soc. Chem. Ind.* [Japan], **36** [4], 168–69*B* (1933).—The results of the study of materials for electrodes are given. Amorphous carbon reacts with zinc oxide at a temperature 50° lower than graphite. For Part I see *Ceram. Abs.*, **11** [7], 407 (1932). M.V.K.

Curious formation of pseudowollastonite during the cooling of a tank. MARCEL BELLIÈRE. *Rev. belge ind. verrières, céram., émail.*, **3** [10], 218–19 (1932).—B. reports the results of a petrographic examination of a crystal formed at the glass surface line of a tank that was shut down for repairs. Chemical analysis and optical examination show this to be a close approximation to pseudowollastonite. The glass being worked was a soda-lime glass. Refractories suffered unusually from corrosion along the melted glass level lines. P.E.C.

Successes and failures with experimental tank blocks. W. J. A. WARREN. *Glass Rev.*, **9** [1], 6–9 (1933).—A survey is made of the technical literature pertaining to the topic. A.A.

Mechanical mixing and transportation of the batch to a glassmelting furnace. V. D. DUBININ. *Keram. i Steklo*, **9** [5], 12 (1933).—Apparatus is described. M.V.K.

Bailey & Sharp tool. ANON. *Glass Ind.*, **14** [8], 87 (1933).—A standard furnace for measuring the softening point of glass, having a built-in cold junction and a base-metal thermocouple, has been placed on the market. In essential points it follows the specifications given by J. T. Littleton. Illustrated. E.J.V.

Polychrome tubes. A. KARSTEN. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 12 (1933).—The use of tubes partitioned longitudinally so that more than one gas may be used in illumination effects is briefly discussed. These are difficult to produce. A lining with colored glasses arranged in various ways is more interesting and more readily manufactured. A photograph shows eight different effects produced by juggling the lining of neon tubes. P.E.C.

Apparatus for cutting glass. ANON. *Rev. belge ind. verrières, céram., émail.*, **3** [4], 85 (1932).—Kraus and Winter of Hamburg offer a device using a steel wheel instead of a diamond for cutting circles and ovals in any desired dimensions from sheet glass. P.E.C.

Apparatus for rapid cutting of Triplex glass. ANON. *Glaces et Verres*, **6** [33], 14–15 (1933).—A flexible string heated by means of electricity is carefully placed on the cut left by a diamond. After several minutes of heating the glass is separated easily. M.V.K.

Review of Soviet inventions. ANON. *Keram. i Steklo*, **9** [4], 29–31 (1933).—A description of new devices utilized in the U.S.S.R. includes (1) method for blowing glass, (2) method for manufacturing curved pane glass, (3) mechanical manufacture of pots for glassmelting, and (4) molds for pressing glass vessels. M.V.K.

Glassmaking accessories. W. MASKILL. *Glass Rev.*, **9** [3], 35–36 (1933).—The three new glassmaking accessories exhibited at the Department of Glass Technology on the occasion of the visit of the Society of Glass Technology to Sheffield in Feb., 1933, are mentioned. Universal Oil Burners, Ltd., exhibited a new unit for oil firing to preheat the atomizing air for a high-pressure atomizer. The second exhibit was by Hall & Pickles, Ltd., who demonstrated a new electrical resistance alloy named "Kanthal" (see *Ceram. Abs.*, **12** [5], 199 (1933)). The third exhibit by Chance Bros., & Co., Ltd., was of the types of burners making use of the new Bornkessel multiple metal jet system, including burners for lamp working, cracking of glassware, and for use in electric lamp and radio tube manufacture. A.A.

Glass bottle making machinery. HAL GUTTERIDGE. Presented at meeting of

Society of Engineers, London, May, 1933; *Pottery Gas.*, **58** [674], 981–85 (1933).—After presenting a flow sheet to illustrate the sequence of operations, G. briefly follows a separate portion of molten glass, sufficient for making one bottle, from the furnace stage to the finished article, describing the mechanical devices used for each stage as they are encountered. The requirements for each machine are enumerated. Illustrated. E.J.V.

Lake Shemeli: an alkaline base for the Ural glass industry. A. D. FEDOSEEV. *Keram. i Steklo*, **9** [4], 13–14 (1933).—F. describes the deposits of mirabilite of high quality found in Lake Shemeli. Details of the composition of mirabilite are given. M.V.K.

What's in a name? Lead crystal and "Lead Crystal." ANON. *Glass Rev.*, **9** [2], 20–23 (1933).—To suppress the misleading descriptions and designations of "lead-crystal glassware," proposals made by the Glass Standard Committee of the Deutsche Glastechnische Gesellschaft and accepted by the German Government Committee are quoted. According to the specifications issued the term "lead crystal" must not be applied to any glass which contains less than 18% lead oxide in the finished glass, and the type of lead crystal is to be explicitly stated as to whether it is pressed ware or cut after a preliminary pressing. The Berlin Chamber of Commerce recognizes under the description "Genuine Lead Crystal" only such products as are produced by hand cutting. A.A.

Mat etching of glass. I–III. M. PARKIN. *Glass Rev.*, **9** [1], 4–6; [2], 25–28; [3], 37–41 (1933).—A review is presented. A.A.

Some experiences in the polishing of lead glass by acid. JACQUES WOLF. *Rev. belge ind. verrières, céram., émail.*, **3** [9], 201–205 (1932); for abstract see article by Dietzel, Tielsch, and Ernyei, *Ceram. Abs.*, **11** [4], 236 (1932), and book by Wolf, *ibid.*, **12** [4], 150 (1933). P.E.C.

Glass, its nature and meaning. HELEN JOHNSON KEYES. *Christian Sci. Mon.*, **25** [189], 7 (1933).—K. discusses the nature of glass and the methods of shaping it, *viz.*, blowing and casting. Various methods of producing novel effects such as crystal formation by devitrification or bubbled textures are described. The work of Walter Dorwin Teague in designing glassware is discussed. Illustrated. E.J.V.

Drawn or blown glass knickknacks. A. G. *Glaces et Verres*, **6** [33], 8–10 (1933).—Fusible glass having a lead base and of different colors is used for the production of objects representing animals, fishes, flowers, trees, etc. Glass rods are heated on a blast flame and when soft are drawn and molded into different shapes. Illustrated. M.V.K.

Glassblowing: an ancient and a modern craft. ANON. *Crockery & Glass Jour.*, **112** [6], 11–13 (1933).—A brief educational article is presented on the technical processes involved in the manufacture of china and glassware. The tools, molds, fire box, and the following processes are described: (1) the blown offhand process, (2) shaping, (3) annealing, (4) finishing processes, (5) cracking off, (6) grinding, and (7) beveling and glazing. Illustrated. C.H.T.

Glass block building featured at Century of Progress. ANON. *Glass Ind.*, **14** [8], 91 (1933).—A description of the Owens-Illinois Glass Co. building, made of 27,000 colored glass blocks, is given. Illustrated. See also *Ceram. Abs.*, **12** [5], 187 (1933). E.J.V.

Bas-relief in wrought glass. ANON. *Glass Ind.*, **14** [8], 88–89 (1933).—A description of a large bas-relief in wrought glass produced by di Lauro by cutting the glass with a jet of sand and acid, exhibited at the French Colonial Exposition in 1931, is given. Illustrated. E.J.V.

Decorative fashioning of glass. II. Diseases resulting from glassworking and hygienic precautions necessary. JACQUES WOLF. *Rev. belge ind. verrières, céram., émail.*, **3** [4], 83–85 (1932).—W. discusses factory ventilation, silicosis causes, handling of acid fumes, diseases caused by silvering, general working conditions, lighting, and plant conditions in general. **III. Different methods of fashioning glass.** *Ibid.*, **3** [5], 106–109 (1932).—W. defines the various methods used in obtaining decorative effects by manipulative processes. **IV. Different methods of glass manipulation.** *Ibid.*, **3** [7], 156–58 (1932).—W. deals with surface decoration of glass: (1) Cutting or engraving; (*a*) net work relief in glass threads, (*b*) relief engraving like the Portland vase, (*c*) deep engraving, (*d*) deep cutting or carving with a diamond, (*e*) point by point designing with a diamond; (2) Painting; (*a*) cold painting and gilding, (*b*) cold painting protected by cementing together two painted glass objects well fitted one to the other so that no cold painted work is exposed to wear, (*c*) painting with enamel colors. The article is generally descriptive of processes. For Part I see *Ceram. Abs.*, **12** [2], 43 (1933). See also book review, *Ceram. Abs.*, **12** [4], 150 (1933). P.E.C.

Decorated mirrors of the painter, Charles Michel. JEAN DANIGRAND. *Clarté*, May, 1932; *Rev. belge ind. verrières, céram., émail.*, **3** [4], 85 (1932).—Reference is made to superior work in mirror decoration in gold and silver. P.E.C.

History of glassmaking. ANON. *Rev. belge ind. verrières, céram., émail.*, **3** [10], 221–22 (1932).—Extracts are taken from De Re metallica (1530) by Georg Landmann, German naturalist, known under the latinized name of Agricola. The article covers primitive glassmaking and is of historical interest only. P.E.C.

Modern evolution of glassmaking. L. VON REIS. *Rev. belge ind. verrières, céram., émail.*, **3** [5], 98–101; [6], 122–26 (1932); see also *Ceram. Abs.*, **9** [12], 1035 (1930). P.E.C.

The scientific worker in the glass industry. ANON. *Glass Rev.*, **9** [6], 86–88 (1933).—According to a leaflet written by W. E. S. Turner, the services which the trained scientific worker can render can be classified as (1) the analysis and control of raw materials and of glass, (2) defects arising in the manufacture and use of glass, (3) the control and improvement of works processes, and (4) constructive research. A.A.

BOOK

History of Glassmaking. Essays on the Varied Arts. By the monk THÉOPHILE. A compilation by Charles de l'Escalopier, published in Paris, 1843. *Rev. belge ind. verrières, céram., émail.*, **3** [3], 54–56 (1932).—The book deals with methods of manufacture of glass. P.E.C.

Book Review

Safety Glass. (Sicherheitsglas.) H. G. BODENBENDER. Chemish-technischer Verlag Bodenbender, Berlin-Steglitz, 1933. 336 pp. 78 illustrations. 18.00 Rm. This book is a detailed account of the history, development, and present manufacture of different types of safety glass. M.V.KONDOIDY

PATENTS

Process of making curved composite glass plates. J. H. SHERTS AND JOHN WILLITS (Duplate Corp.). U. S. 18,918, Aug. 22, 1933 (reissue).

Annealing leer. P. L. GEER (Amco, Inc.). U. S. 1,918,962, July 18, 1933. GARLAND LUFKIN (Owens-Illinois Glass Co.). U. S. 1,919,167, July 18, 1933.

Machine for forming hollow glassware. E. L. HUGHES (Owens-Illinois Glass Co.). U. S. 1,919,162, July 18, 1933. L. D. SOUBIER (Owens-Illinois Glass Co.). U. S. 1,919,177, July 18, 1933.

Glass roofing. ARNO SHUMAN (Pennsylvania Wire Glass Co.). U. S. 1,919,174, July 18, 1933.

Glassware forming machine. L. D. SOUBIER AND J. H. TREECE (Owens-Illinois Glass Co.). U. S. 1,919,176, July 18, 1933.

Apparatus for drawing tubing containing a stripe of contrasting glass. W. H. SAID (Corning Glass Works). U. S. 1,919,259, July 25, 1933.

Low expansion black glass and method of producing it. W. C. TAYLOR (Corning Glass Works). U. S. 1,919,264, July 25, 1933. A black borosilicate glass which is completely opaque to visible light contains, as coloring agents, iron and titanium sufficient in amount to color the glass black.

Process for providing a transparent coating on glass surfaces. K. KONISHI AND SEISUKE KODAMA. U. S. 1,919,517, July 25, 1933. A process for providing a transparent coating or film upon glass surfaces comprises dissolving cellulose acetate in a slowly drying solvent, diluting the solution with a liquid selected from the group consisting of acetone, benzol, and benzin-alcohol, coating the respective glass article with the composition, and subjecting coated articles to the action of benzol vapor.

Process of treating laminated glass to prepare it for sealing. G. B. WATKINS (Libbey-Owens-Ford Glass Co.). U. S. 1,919,757, July 25, 1933, and 1,924,580, Aug. 29, 1933.

Wire glass. NED WELKOVITZ AND A. S. GOLDSTEIN. U. S. 1,919,873, July 25, 1933.

Leer. LOUIS BEON (Salem Glass Works). U. S. 1,919,923, July 25, 1933.

Machine for making articles from molten material. F. H. LOBB (Hartford-Empire Co.). U. S. 1,920,908, Aug. 1, 1933.

Method and apparatus for drawing glass. W. J. WOODS (Corning Glass Works). U. S. 1,920,336, Aug. 1, 1933. A. E. SPINASSE. U. S. 1,925,414, Sept. 5, 1933. J. A. DE SILVA (Corning Glass Works). U. S. 1,920,366, Aug. 1, 1933.

Structural glass for covering walls and ceilings. W. D. HADLEY. U. S. 1,920,503, Aug. 1, 1933.

Means for and method of delivering molten glass charges to shallow molds. K. E. PEILER (Hartford-Empire Co.). U. S. 1,920,593, Aug. 1, 1933.

Laminated glass and process of making. J. C. ZOLA (Duplate Corp.). U. S. 1,920,619, Aug. 1, 1933. FRANK FRASER AND G. B. WATKINS (Libbey-Owens-Ford Glass Co.). U. S. 1,921,612, Aug. 8, 1933. J. W. KAMERER AND E. L. FIX (Duplate Corp.). U. S. 1,922,893, Aug. 15, 1933. W. H. MOSS (Celanese Corp. of America). U. S. 1,923,111, Aug. 22, 1933.

Process and apparatus for separating glass sheets. H. S. HEICHERT (Pittsburgh Plate Glass Co.). U. S. 1,920,641, Aug. 1, 1933.

Glass drawing tank. H. L. HALBACH (Pittsburgh Plate Glass Co.). U. S. 1,920,692, Aug. 1, 1933.

Glassware transfer device. H. W. INGLE (Hartford-Empire Co.). U. S. 1,921,389, Aug. 8, 1933.

Glassware conveyer. H. W. INGLE (Hartford-Empire Co.). U. S. 1,921,390, Aug. 8, 1933.

Receiver for glassforming machines. E. H. LORENZ (Hartford-Empire Co.). U. S. 1,921,393, Aug. 8, 1933.

Apparatus for washing sheet glass. L. J. PIERCE (American Window Glass Co.). U. S. 1,921,479, Aug. 8, 1933.

Cutting table. E. J. STINE (American Window Glass Co.). U. S. 1,921,489, Aug. 8, 1933.

Contact glass. FERDINAND FERTSCH AND HANS HARTINGER (Carl Zeiss). U. S. 1,921,971, and 1,921,972, Aug. 8, 1933.

Glass tube cutter. E. H. FAHRNEY. U. S. 1,922,426, Aug. 15, 1933.

Sheet glass apparatus. J. H. REDSHAW (Pittsburgh Plate Glass Co.). U. S. 1,922,327, Aug. 15, 1933.

Luminair. T. W. ROLPH (Holophane Co., Inc.). U. S. 1,922,331, Aug. 15, 1933.

Method of indexing glass photomechanically. KARL GUNDLACH (Carl Zeiss). U. S. 1,922,434, Aug. 15, 1933.

Device for cutting sheet material. D. H. GOODWILLIE AND E. L. WALTERS (Libbey-Owens-Ford Glass Co.). U. S. 1,922,620, Aug. 15, 1933. H. R. SCHUTZ AND H. E. ROBINSON (Libbey-Owens-Ford Glass Co.). U. S. 1,922,641, Aug. 15, 1933.

Apparatus for producing sheet glass. J. A. REECE (Libbey-Owens-Ford Glass Co.). U. S. 1,922,637, Aug. 15, 1933.

Method of and apparatus for feeding melting furnaces. E. C. STEWART (Tygart Valley Glass Co.). U. S. 1,922,827, Aug. 15, 1933.

Glass rolling apparatus. W. G. KOUPAL (Pittsburgh Plate Glass Co.). U. S. 1,922,894, Aug. 15, 1933.

Plate glass polishing block. J. H. FOX (Pittsburgh Plate Glass Co.). U. S. 1,922,912, Aug. 15, 1933.

Safety glass. W. J. BELKNAP (Libbey-Owens-Ford Glass Co.). U. S. 1,923,070, Aug. 22, 1933.

Process of melting glass. M. P. LOCKE (Corning Glass Works). U. S. 1,923,221, Aug. 22, 1933.

Nonshatterable glass and method of making. M. J. WALSH (Kelco Co.). U. S. 1,923,245, Aug. 22, 1933.

Machine for feeding molten glass. K. E. PEILER (Hartford-Empire Co.). U. S. 1,923,554, Aug. 22, 1933.

Ophthalmic lens. A. E. GLANCY (American Optical Co.). U. S. 1,923,572, Aug. 22, 1933. H. H. STYLL (American Optical Co.). U. S. 1,925,575, Sept. 5, 1933.

Leer. F. T. NESBITT (Owens-Illinois Glass Co.). U. S. 1,923,581, Aug. 22, 1933.

Leer for annealing glassware. GARLAND LUFKIN (Owens-Illinois Glass Co.). U. S. 1,923,941, Aug. 22, 1933.

Glass furnace. GARLAND LUFKIN (Owens-Illinois Glass Co.). U. S. 1,923,942, Aug. 22, 1933.

Bifocal lens. H. A. TOULMIN, JR. (The Univis Corp.). U. S. 1,924,336, Aug. 29, 1933.

Unsymmetrical objective lens system. A. W. TRONNIER. U. S. 1,924,527, Aug. 29, 1933.

Glass surfacing tool. J. L. DRAKE (Libbey-Owens-Ford Glass Co.). U. S. 1,924,597, Aug. 29, 1933.

Method and apparatus for drawing sheet glass under pressure. E. T. FERNGREN (Libbey-Owens-Ford Glass Co.). U. S. 1,924,599, Aug. 29, 1933.

Heat-resisting glass giving daylight effects. W. H. RISING (Corning Glass Works).

U. S. 1,924,752, Aug. 29, 1933. A sodium borosilicate glass containing an oxide of the metallic elements of the second periodic group has an atomic weight between 60 and 120 and also contains cobalt and ferrous oxide.

Glass mold. R. M. HUNTER. U. S. 1,925,096, Sept. 5, 1933.

Glass and process of making. P. E. HARTH (National Pigments and Chemical Co.). U. S. 1,925,381, Sept. 5, 1933. In the art of making glass the process comprises mixing glassforming materials including barium aluminate and fusing the batch.

Electric melting of glass, etc. HARTFORD-EMPIRE CO. Brit. 394,709, July 12, 1933.

Manufacture of wired glass sheets. CHANCE BROS. & CO., LTD., W. H. S. CHANCE, AND L. GORMAN. Brit. 394,783, July 12, 1933.

Process of and apparatus for the production of flashed molded glassware. GLASHÜTTENWERKE VORM J. SCHREIBER & NEFFIN. Brit. 395,599, July 26, 1933.

Method of fining glass and glass produced thereby. CORNING GLASS WORKS. Brit. 396,015, Aug. 2, 1933.

Manufacture of unsplinterable composite articles such as safety glass. RÖHM AND HAAS AKT.-GES. Brit. 396,097, Aug. 10, 1933.

Composite or laminated glass and its production. F. ECKERT. Brit. 396,313, Aug. 10, 1933.

Manufacture of safety glass. C. W. BONNIKSEN. Brit. 396,713, Aug. 23, 1933.

Process of tempering glass by jets of air directed at right-angles to the surface. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY & CIREY. Brit. 397,395, Aug. 30, 1933.

Method of and apparatus for pouring molten glass for feeding sheet-forming apparatus. FORGES & ATELIERS DE CONSTRUCTIONS ÉLECTRIQUES DE JEUMONT. Brit. 397,400, Aug. 30, 1933.

Glass-working machines. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 397,425, Aug. 30, 1933.

Apparatus for drawing glass tubes, etc., containing a stripe of contrasting glass. CORNING GLASS WORKS. Brit. 397,444, Aug. 30, 1933.

Laminated glass. WM. H. MOSS (Camille Dreyfus). Can. 330,610, Feb. 28, 1933. Cellulose acetate treated with H_2O_2 before use in the manufacture of laminated glass is rendered substantially fast to light. (*C.A.*)

Glass transparent to ultra-violet light. CAMILLE DREYFUS. Can. 330,842, March 14, 1933. A layer of a plastic material comprising cellulose acetate and a tartrate ester as plastifier is interposed between sheets of glass of high quartz content. (*C.A.*)

Laminated glass. JAMES F. WALSH (Celluloid Corp.). Can. 330,901, March 14, 1933. Laminated glass has at least one layer of a plastic sheet containing cellulose nitrate interposed between sheets of glass and a film containing cellulose nitrate and not more than 50% of ester gum based on the weight of the cellulose nitrate employed. (*C.A.*)

Apparatus for the continuous production of sheet glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY ET CIREY. Fr. 741,798, Feb. 20, 1933. (*C.A.*)

Apparatus for tempering glass, steel, etc., by air. LEONARDO MOSMIERI AND GINO DAL PINO. Fr. 741,869, Feb. 22, 1933. (*C.A.*)

Tempering glass. HENRY GEORGES (Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny et Cirey). Fr. 742,029, Feb. 25, 1933. The glass is heated in a field of high frequency of which it forms the dielectric. (*C.A.*)

Glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY ET CIREY. Fr. 744,136, April 12, 1933. Means for feeding molten glass in making glass objects are described. (*C.A.*)

Apparatus for cooling glass. HANS M. ESCHENBACHER. Ger. 574,295, April 11, 1933. (*C.A.*)

Apparatus for ladling molten glass from a furnace to a rolling machine. S. BENDIT & SÖHNE. Ger. 574,432, April 13, 1933. (*C.A.*)

Apparatus for cooling glass plates. PAUL ESCOLE (Forges et ateliers de construction électriques de Jeumont). Ger. 577,277, May 29, 1933. (*C.A.*)

Structural Clay Products

Water movement in stiff-mud ware and its relation to drying. ELLIS LOVEJOY. *Jour. Amer. Ceram. Soc.*, **16** [9], 405–11 (1933).

Slip to produce gray brick; clay mixtures to make buff and gray colors. L. P. COLLIN. *Brick Clay Rec.*, **83** [1], 24–26 (1933).—Data on tests involving 70 slips prepared for producing gray brick are presented. Light buff and gray were produced.

While the slip produces a good color a commercial application of this process is not yet feasible. See also *Ceram. Abs.*, **11** [6], 367 (1932). E.J.V.

Porous plastics made by use of calcium alloys. C. C. DOWNIE. *Metal Prog.*, **24** [2], 46 (1933).—A highly and uniformly porous mass is produced by the addition of aluminum or alloys of calcium and magnesium to cement, concrete, and clay products. Caustic soda added to the water prevents the formation of oxide on particles of aluminum. R.H.H.P., JR.

Stiff-plastic brickmaking. JOHN PROCTOR. *Trans. Ceram. Soc.* [Eng.], **31**, 392–98 (1932); for abstract see *Ceram. Abs.*, **11** [8], 454 (1932). C.H.T.

Practical clayworking. IV. ANON. *Brit. Clayworker*, **42** [494], 62–64 (1933).—Portable conveyers and types of manufactured goods are discussed. The classifications of brick according to method of manufacture and according to quality are given. **V.** *Ibid.*, **42** [496], 132–34 (1933).—Breaking and crushing strengths, freezing and thawing tests to which brick and tile may be subjected, various types of tile, and the preparation of clay for use in the manufacture of building brick are discussed. For Part III see *Ceram. Abs.*, **12** [8], 305 (1933). R.A.H.

Bending strength of common brick and strength of cubes and samples made of two common brick halves. O. DRÖGSLER. *Tonind.-Ztg.*, **57** [54], 629–30 (1933).—Results are given of new experiments with common brick. Common brick of high strength show high bending strength. The ratio of strength over bending strength is not a constant but will decrease with an increasing strength. The ratio will vary for different brands of brick and different testing methods (cubes $2^1/_2$, $2^1/_4$, and 2 in. in length, respectively, samples of two brick halves with mortar joint, etc.). Bending tests may be used for plant control provided that a chart is made based on results with standard samples. W.M.C.

Tests of common brick using alumina cement joints. L. BLOCH. *Tonind.-Ztg.*, **57** [59], 688–89 (1933).—The use of alumina cement decreases considerably the time of the experiments as compared with ordinary cement. W.M.C.

De-airing stiff mud for common brick. A. HIELSCHER. *Tonind.-Ztg.*, **57** [56], 648–50 (1933); see *Ceram. Abs.* **11** [5], 304 (1932). W.M.C.

Better clay products through evacuation. C. H. VIVIAN. *Clay Prod. News*, **6** [7], 4–6 (1933).—The withdrawal of air from stiff-mud bodies increases strength and improves the appearance of the ware. Of the three methods available for air removal, (1) pressure, (2) replacement, and (3) evacuation, the latter seems to be the best for stiff-mud bodies. The results of tests on evacuated clays show a marked increase in desirable properties. C.H.T.

Cementing material of sand-lime brick. An X-ray and microscopical investigation. GEOFFREY GRIME AND GEO. E. BESSEY. *Trans. Ceram. Soc.* [Eng.], **32** [1], 14–21 (1933).—Sand-lime brick both prepared in the laboratory and of commercial origin were examined chemically, microscopically, and by the X-ray powder method. The hydrated calcium silicate forming the cement is present in an amorphous or colloidal condition but may be converted by atmospheric carbon dioxide partially or wholly to calcite and hydrated silica gel. C.H.T.

Hollow sand-lime tile. F. TRIFFTERER. *Tonind.-Ztg.*, **57** [53], 616–18 (1933).—The manufacture of hollow sand-lime tile is described. A large machine is shown for pressing large-sized tile. W.M.C.

Addition of sugar to sand-lime brick. ANON. *Tonind.-Ztg.*, **57** [57], 664–65 (1933); see also *Ceram. Abs.*, **12** [5], 190 (1933). W.M.C.

Influence of cutting on strength of cubes made from building materials. H. KOSTRON. *Tonind-Ztg.*, **57** [65], 760–61 (1933).—In most cases test cubes are cut from standard brick. The influence of cutting on the strength of the samples was studied. Four different types of brick were cut by means of a hack saw and a rotating saw. The data obtained show only small differences for a small number of experiments. A standard method of cutting the samples should be introduced into the standard specifications for brick. W.M.C.

Efflorescences in brick. II. ALIX CORNILLE. *Rev. mat. constr. trav. pub.*, No. 284, pp. 89–90*B* (1933).—Efflorescences appearing during storing of the brick and on buildings are due to an extreme porosity of the brick. The porosity, due to insufficient firing, is accompanied by the solubility of elements such as lime and calcium sulfate. Tests for determining porosity are discussed. For Part I see *Ceram. Abs.*, **12** [8], 298 (1933). M.V.K.

Shale-ash brick causing masonry destructions. HAEGERMANN. *Tonind.-Ztg.*, **57** [52], 604–606; [54], 628–29 (1933).—Shale-ash brick were used in an industrial building. After some time, bad destructions were observed caused by the high sulfur

content of the brick which amounted to more than 5%. The volume of the brick increased by the formation of calcium sulfate and by double salts of calcium and alkali sulfates. The sulfates concentrating in the outer layers of the brick caused the formation of crystals between the brick and the mortar. No calcium aluminum sulfate has been found, however. No ashes should be used for brick containing more than 1% sulfuric anhydride. The same is true for the use of shale ash in manufacturing porous concrete (gas-concrete). Illustrated. W.M.C.

Protection of buildings by means of silica ester paints. W. GRAULICH. *Tonind.-Ztg.*, **57** [58], 677 (1933).—These paints will give a thin porous coating of silica on the building. The amount of silica may be changed within a wide range. Coatings of this type may also be added to refractory coatings of furnace linings. W.M.C.

Preventing leakage of rain water in brick buildings. ANON. *Tonind.-Ztg.*, **57** [55], 639–41 (1933).—This is a reprint of a chapter from the book by W. Thein (*Ceram. Abs.*, **11** [8], 455 (1932)). Details are given for the construction of different types of masonry. W.M.C.

Manufacture of lightweight brick. ANON. *Brick Clay Rec.*, **83** [1], 26 (1933); for abstract see *Ceram. Abs.*, **12** [5], 190 (1933).

"Fiskelite" tapestry brick. ANON. *Clay-Worker*, **100** [1], 14–15 (1933).—A description of the 20% lighter hollow brick produced on a regular stiff-mud machine with a de-airing attachment and the addition of a new end-closing attachment between the die and cutter is given. Illustrated. See also *Ceram. Abs.*, **12** [9], 330 (1933). E.J.V.

Reinforced brick masonry for flexural limitations. M. O. WITHEY. *Brick Clay Rec.*, **83** [1], 23 (1933).—Results of tests on reinforced brick beams show that it is possible to develop a high degree of flexural strength. Other conclusions are listed. E.J.V.

Reinforced brickwork chosen for first reconstruction at Long Beach, California. ANON. *Ceram. Age*, **21** [6], 185 (1933).—Brickwork which meets the requirements of earthquake resistance demanded by the new regulations is described and illustrated. F.G.H.

Wire molded in quake-proof brick. ANON. *Popular Sci. Monthly*, **122** [6], 30 (1933).—Brick construction with interlocking wires is described and illustrated. F.G.H.

Synthetic stone. H. C. PEFFER, R. L. HARRISON, AND R. N. SHREVE. *Ind. Eng. Chem.*, **25** [7], 719–22 (1933); for abstract see *Ceram. Abs.*, **12** [8], 298 (1933); see also *ibid.*, **12** [9], 330 (1933). F.G.H.

Hard-fired brick for road construction. ANON. *Tonind.-Ztg.*, **57** [54], 627–28 (1933); for abstract see article by Hielscher, *Ceram. Abs.*, **12** [8], 298 (1933). W.M.C.

World's most unusual brick house. ANON. *Brick Clay Rec.*, **83** [1], 14–17 (1933).—A full description of the reinforced brick masonry house at A Century of Progress is given. Illustrated. E.J.V.

Testing of material and control of manufacturing in brick plants. W. DAWIHL. *Tonind.-Ztg.*, **57** [50], 577–80 (1933).—This is a review of testing methods used in plant and laboratory control of manufacturing brick and tile. Difficulties and tests for eliminating them are discussed as applied in different stages of manufacturing. Illustrated. W.M.C.

Future of brick architecture. K. W. SCHULZE. *Tonind.-Ztg.*, **57** [53], 614–16 (1933).—Modern brick houses are shown as well as steel-tile structures. W.M.C.

Statistics as an important aid in brick plants. W. SCHNELL. *Tonind.-Ztg.*, **57** [59], 686–88; [61], 709–10 (1933).—Forms used in organizing a brick plant are shown. W.M.C.

Centralization of the German brick industry. W. MÜGGE. *Tonind.-Ztg.*, **57** [65], 755–56 (1933). W.M.C.

Fixing prices in the German brick industry. O. LENGERSDORFF. *Tonind.-Ztg.*, **57** [64], 745–46 (1933). W.M.C.

PATENTS

Porous molded product and process of manufacturing. M. H. KLIEFOTH (C. F. Burgess Laboratories, Inc.). U. S. 1,919,372, July 25, 1933. A porous molded product comprises a mixture of a filler, alkali silicate, and alkali tetraborate puffed by heat into a rigid mass, the alkali tetraborate being present in an amount less than that of the alkali silicate.

Process of making clay products. E. E. FISHER AND M. A. BAERNSTEIN (National Pigments and Chemical Co.). U. S. 1,922,083, Aug. 15, 1933. In the art of making clay products the process comprises adding to the ceramic mix a barium aluminate in an amount sufficient to prevent surface discoloration.

Face brick. J. E. MINTER (Dixie Brick Co., Inc.). U. S. 1,923,636, Aug. 22, 1933.

Impregnation process. G. G. HEGHINIAN. U. S. 1,923,726, Aug. 22, 1933.

Light-weight ceramic tile and method of making. H. T. Coss (Johns-Manville Corp.). U. S. 1,925,985, Sept. 5, 1933.

Apparatus for producing brick, etc., with indented and sanded face and ends. H. H. BAILEY, R. BARKER, AND T. JONES. Brit. 395,696, Aug. 2, 1933.

Manufacture of brick. H. NIELSEN. Brit. 396,590, Aug. 16, 1933.

Method and means for ornamenting brick or building blocks. B. C. LAMB AND A. E. LAMB. Brit. 397,331, Aug. 30, 1933.

Manufacture of brick or blocks. L. HALL. Brit. 396,381, Aug. 16, 1933.

Porous brick. HENRY V. ALLEN. Fr. 742,759, March 16, 1933. Wood charcoal is mixed with clay and fired. (*C.A.*)

Brick. CHEM. LABORATORIUM FÜR TONINDUSTRIE UND TONINDUSTRIE-ZEITUNG H. SEGER & E. CRAMER G.M.B.H. Ger. 560,095, April 7, 1933. Hollow brick are molded from clay in a known manner and filled with a cellular clay mass of lower specific gravity obtained, *e.g.*, by incorporating CaC_2 or powdered metal into wet clay. The brick are then dried and fired as usual. Manufacturing details are described. (*C.A.*)

Refractories

Papers from the Second Symposium on the Physical Chemistry of the Alumina-Silica Refractories. I. Rôle of silicon and aluminum in complex silicates. B. E. WARREN. *Jour. Amer. Ceram. Soc.*, **16** [9], 412–17 (1933). **II. Structure of sillimanite and related materials.** W. H. TAYLOR. *Ibid.*, pp. 418–20 (1933). **III. Bauxites and mullites.** M. E. NAHMIAS. *Ibid.*, pp. 420–21 (1933). **IV. Discussion on the physical chemistry of the alumina-silica refractories.** R. W. G. WYCKOFF. *Ibid.*, p. 422 (1933).

Discussion on "theory of spalling." F. H. NORTON. *Jour. Amer. Ceram. Soc.*, **16** [9], 423–24 (1933).

Classification and definition of specialized refractories. HAROLD E. WHITE. *Bull. Amer. Ceram. Soc.*, **12** [8], 252–56 (1933).

Recent research in special refractories. Noteworthy advances. E. PRESTON. *Glass Rev.*, **9** [7], 101–105 (1933).—Researches of H. Salmang and N. Planz (*Ceram. Abs.*, **12** [6], 229 (1933)) and of J. Schmauser (*ibid.*, **12** [8], 301 (1933)) are discussed. A.A.

Examination of some special refractories. MARCEL LÉPINGLE. *Rev. belge ind. verrières, céram., émail.*, **4** [2], 31–34; [3], 59–61; [4], 79–82 (1933).—L. reviews the theory of refractories of all types, quoting current opinion. His special interest is in refractories other than fire clay. Sources and preparation of the materials and manufacturing problems are given. Standard methods for determining the physical properties are listed, and tabulations of results are quoted covering standard products. Tabulations of results on European refractories are of interest. A brief bibliography accompanies the article. See also *Ceram. Abs.*, **12** [7], 266 (1933). P.E.C.

Refractories for the manufacture of glass. F. S. THOMPSON AND H. M. KRANER. *Ind. Eng. Chem.*, **25** [8], 856–64 (1933).—The development of glassmaking is traced briefly and the status of the refractories used and the part they played in this development are described. The chemical aspects of the manufacture of refractories and the chemical considerations in their use are discussed. Modern refractories and their application to the glass industry are discussed under the following headings: (1) clay flux blocks, (2) flux blocks of crystalline minerals bonded with clay or other binders, (3) flux-block manufacture by the electric foundry method, and (4) superstructure refractories for use above the glass contact line, including silica, fire clay, cyanite, Indian sillimanite, electric cast, andalusite, high-aluminous refractories, etc. Numerous illustrations and diagrams are included. F.G.H.

Insulating refractories. ANON. *Blast Fur. Steel Plant*, **21** [7], 387 (1933); *Refrac. Jour.*, **9** [5], 174 (1933).—Shrinkage under heat treatment, transverse strength, and crushing strength were three tests for specifications proposed at the Pittsburgh meeting of Committee C-8 on Refractories of the A.S.T.M. C.H.T.

Sidelights on refractories. R. PERCIVAL SMITH AND A. MCKENDRICK. *Trans.*

Ceram. Soc. [Eng.], **32** [4], 167–84 (1933).—The relation between refractories and ingot cost and factors affecting the selection of materials for the lining of steel ladles is discussed. Illustrated. See also *Ceram. Abs.*, **12** [1], 22 (1933). C.H.T.

Physical structure of refractory materials. T. S. CURTIS. *Rev. belge ind. verrières, céram., émail.*, **3** [10], 223–24 (1932); for abstract see *Ceram. Abs.*, **8** [1], 36 (1929). P.E.C.

Studies of refractory materials. Dolomite. ANON. *Refrac. Jour.*, **9** [6], 231 (1933).—The occurrence and properties of dolomite are briefly discussed. **Corundum.** *Ibid.*, **9** [7], 275 (1933). **Spinel.** *Ibid.*, **9** [8], 290 (1933). C.H.T.

Note on the permeability of refractory materials to gases. A. E. J. VICKERS. *Jour. Soc. Glass Tech.*, **17** [66], 93 (1933).—Measurements of the porosities and of the permeabilities of refractories to gases are reported. Porosity measurements offer no guide to permeability except under special circumstances not likely to occur in commercial usage. An apparatus is described which enables measurements of permeability to be made at elevated temperatures. The influence of temperature on permeability has been measured in the case of some experimental refractories. C.H.T.

Behavior of refractory materials under torsion at different temperatures. A. L. ROBERTS AND J. W. COBB. *Trans. Ceram. Soc.* [Eng.], **32** [1], 22–44 (1933); for abstract see *Ceram. Abs.*, **12** [1], 19 (1933). C.H.T.

Refractory silicon carbide cements. F. CROSET. *Arts & Métiers*, pp. 101–104 (1933). (*C.A.*)

Refractories from the viewpoint of the foundry. L. LOUCHAMBON. *Rév. fonderie moderne*, **27**, 131–34 (1933).—A general discussion is given of sand and materials used in the foundry for molding, cores, linings of furnaces, etc., and their particular requirements for these purposes. (*C.A.*)

Evaluation of cellulose sulfite lye. A. EDWARDS AND P. F. F. CLEPHANE. *Trans. Ceram. Soc.* [Eng.], **31**, 417–21 (1932).—The strength of the lye best suited for addition in the preparation of silica cement and silica brick was found by a determination of the lowering of the surface tension of water. A list of reagents and a method of chemical determination of cellulose sulfite lye are given. C.H.T.

Fritted corundum. L. F. *Rev. belge ind. verrières, céram., émail.*, **3** [9], 199–201 (1932); see also *Ceram. Abs.*, **12** [7], 266 (1933). P.E.C.

Use of alumina for highly refractory articles. W. J. A. WARREN. *Glass Rev.*, **9** [4], 55–58 (1933).—A survey is made of some of the recently published work on this subject. A.A.

Reciprocal dissolving of silica and alumina at high temperatures. E. S. *Sprechsaal*, **66** [26], 438–39 (1933).—Cases from practice are described in which it was observed that silica and alumina masses dissolve each other at high temperature when in direct contact, and that the alumina silicate is more strongly dissolved by silica than the silica by the alumina compounds. The contact between basic grog brick with Dinas brick or natural sandstone and similar products should be avoided. The dissolving action of both materials on each other is considerably lowered, however, when they are mixed. An acid or basic brick improves its quality with an increase in the acid or basic material present in it; neutral brick with an equally high basic or acid material have the least refractoriness. M.V.K.

Utilization of nepheline in the aluminium industry. ANON. *Ind. chimique*, **20** [231], 286 (1933).—The methods employed for using nepheline (silicate of alumina, soda, and potash) are (1) treatment of the mineral by mineral acids, or (2) treating it in an electric furnace in order to convert the alumina of the nepheline into a slag of the aluminate of lime. According to the last method, silicon in the state of ferrosilicon is recuperated also when adding iron ore. M.V.K.

Preparation of aluminum oxide-kaolin crucibles. O. RUFF AND O. BRETSCHNEIDER. *Chem.-Ztg.*, **57**, 116 (1933).—Aluminum oxyhydrate is prepared by the Bayer method from bauxite by fusing with caustic soda; it contains about 60% Al_2O_3. It is heated at 1000°C or higher for 1 hr., is mixed with 0.4 kg. kaolin and 1 liter 0.2 *n* HCl per 1 kg. and milled for 12 hr. in a ball mill. Then it is heated with direct flame while being stirred vigorously till fusing begins, poured into forms, left for 1 day in air, and further heated 4 hr. to 900°C; after cooling it is again heated slowly in the tungsten wound furnace to 1650°C and kept at this temperature for ¼ hr. The finished objects are not porous, are very resistant to temperature changes, and have a linear shrinkage of 27%. J.G.T.

Constitution and properties of bauxite as a refractory material. BERNARD LONG. *Céramique*, No. 538, pp. 1–12 (1933).—L. considers bauxite as made up of the minerals kaolinite, diasporite, and gibbsite and gives proof to support the belief. For refractory

materials it must contain less than 5% iron which is usually included as hematite or goethite. According to the relative proportions of the parent minerals bauxite may vary in silica content from 2 to 40% and in alumina content from 40 to 75%. Technical data on bauxite are given as follows: (1) expansion curves for bauxites of different compositions, (2) load test data, and (3) spectrographs showing changes taking place in firing. M.H.B.

Bauxites containing diaspore. J. DE LAPPARENT. *Compt. rend.*, **196**, 187–88 (1933).—Distribution indicates that the diaspore is the final product of diagenesis and that its presence denotes formation of such bauxites under conditions of greater pressure and higher temperature than those producing böhmite-containing bauxites. See also article by Hocart and de Lapparent, *Ceram. Abs.*, **10** [4], 298 (1931). (*C.A.*)

X-ray studies on bauxite and mullite. M. E. NAHMIAS. *Z. Krist.*, **85** [5–6], 355–69 (1933).—It was shown by means of Debye spectrographs that no stable crystalline form exists between sillimanite, $Al_2O_3 \cdot SiO_2$, and mullite, $3Al_2O_3 \cdot 2SiO_2$. All the excess SiO_2 or Al_2O_3 is found mixed with mullite either in the form of tridymite or corundum. Previous experimenters concluded that it is impossible to consider mullite as another allotropic form of the system $Al_2O_3 \cdot SiO_2$. The question of the decomposition of crystalline kaolinite when calcined and its transformation into mullite and tridymite is discussed. Experiments are given to show that kaolinite decomposes into γAl_2O_3 and amorphous silica at about 450°C. No change is noted in the Debye spectrum even at 950°C. It is not till about 1050°C that mullite is completely formed. Certain preliminary results concerning the structure of mullite are then taken up. There is shown the impossibility of the construction of an elementary cell preserving the formula and density of mullite, such as is found in recent tables. Bauxite is discussed and its relationship to the silico-aluminate refractories is treated. According to a hypothesis the slight differences observed in the spectra of the different mullites analyzed are due to the formation of a solid solution of TiO_2 and Fe_2O_3 with mullite. G.R.S.

Crystal structure of diaspore. KATSUTOSHI TAKANE. *Proc. Imp. Acad.* [Tokyo], **9**, 113–16 (1933).—Laue photographs show the mineral to be orthorhombic holohedral with 2 molecules of $H_3Al_3O_4$ in the unit cell. The space group is V^{16}. The structure is like that of chrysoberyl, the Al being surrounded by 3 O and 3 OH in octahedral arrangement. Calculated and observed intensities agree within experimental error. (*C.A.*)

Advantages of siemensite as a refractory material. ANON. *Ind. chimique*, **20** [232], 385 (1933); *Iron Coal Trades Rev.*, **126** [3405], 857–59 (1933); see article by Schmauser, *Ceram. Abs.*, **12** [8], 301 (1933); see also article by Preston, this issue, p. 374.

Method for preparation of refractory materials containing spinel and forsterite. KH. S. NIKOGOSYAN AND N. L. DILAKTORSKIĬ. *Mineral Suir'e*, **7** [2–3–4], 20–23 (1932).—A preliminary report is presented. (*C.A.*)

Magnesite refractories. II. Effect of chemical composition on their quality. SEIJI KONDO AND HIROSHI YOSHIDA. *Jour. Soc. Chem. Ind.* [Japan], **36** [4], 167–68*B* (1933).—Magnesite refractories with additions of silica, alumina, lime, ferric oxide, etc., were investigated with regard to their porosity, specific gravity, resistance to spalling and slaking, and softening at high temperatures. For Part I see *Ceram. Abs.*, **12** [4], 159 (1933). M.V.K.

Magnesite brick. ANON. *Brit. Clayworker*, **42** [494], 66–69 (1933).—A description of the mining of magnesite ore and sorting, calcining, dead-burning, crushing, tempering, forming, drying, and firing of brick made from the ore is given. R.A.H.

Drying of magnesite brick. Volume changes accompanying hydration. J. H. CHESTERS AND W. WEYL. *Trans. Ceram. Soc.* [Eng.], **32** [5], 201–17 (1933).—In a previous paper on the "Souring of dead-burned magnesite," (*Ceram. Abs.*, **11** [12], 619 (1932)) the authors suggested that the cracking of magnesite brick during drying was caused by a volume expansion accompanying the formation of magnesium hydrate (Brucite). X-ray analysis confirms the formation of Brucite during souring, while the measurement of test pieces before and after hydration shows a considerable expansion. This expansion is accompanied by serious cracking, and further hydration leads to complete crumbling of the brick. A study has been made of the influence of drying conditions, *e.g.*, speed and humidity of draft, temperature, etc., on the expansion, an apparatus having been devised by means of which the length change of a cylindrical test piece heated in a controlled atmosphere may be observed continuously. The total expansion after drying and cooling is found to be greatly influenced by variations in draft. The most rapid expansion occurs when a wet test piece is maintained in the temperature region 85 to 100°C. Above 100°C the water concentration (except in an autoclave) falls off rapidly, and, in practice, little further expansion is likely to occur. The determination of the increase in hydrate in specimens dried under controlled condi-

tions shows that a qualitative relationship exists between hydration and linear expansion, but that, until the hydration expansion is sufficient to compensate the drying shrinkage, no resultant expansion occurs. The drying of test pieces *in vacuo* shows the possibility of lowering the drying time without raising the temperature and hence the hydrate formation. The possibility of applying vacuum drying for large shapes is suggested. C.H.T.

Manufacture of magnesite brick and new methods for their employment in metallurgy. KILESO AND CHEKASINOV. *Metallurgia*, **7** [5], 27–36 (1932); abstracted in *Stal*, **3** [1–2], 160 (1933).—The authors describe (1) characteristics of raw materials, (2) their preparation, (3) molding, (4) drying, (5) firing in a Mendheim chamber furnace (maximum temperature 1650°), (6) enumeration of bonding agents used, and (7) experiments with additions of iron ore. The composition of the brick is 4.3% SiO_2, 4.7% Fe_2O_3, 3.14% Al_2O_3, 3.88% CaO, 88.87% MgO. The refractoriness according to Seger is 38; specific gravity 3.54. M.V.K.

Shrinkage of magnesite-containing bodies. A. KRIEGER. *Tonind.-Ztg.*, **57** [33], 382–83 (1933).—This is a discussion of a paper by Nitzsche (*Ceram. Abs.*, **12** [5], 193 (1933)). W.M.C.

Shrinkage of magnesite. H. NITZSCHE. *Tonind.-Ztg.*, **57** [49], 570 (1933).—This is a discussion of the preceding paper by Krieger. The most satisfactory type of magnesite for use in magnesia cement will provide a large amount of free $MgCl_2$. W.M.C.

Critical examination of glass tank blocks. DEUTSCHE LIBBEY-OWENS GES. *Rev. belge ind. verrières, céram., émail.*, **3** [7], 146–50; [8], 172–75 (1932); abstracted in *Sprechsaal*, **66** [26], 441 (1933); *Glastech. Ber.*, **11** [4], 148–50 (1933).—The paper discusses the effects of composition, grain size, and structure on corrosion. The summary is as follows: (1) For the estimation of the value of a glass tank block it is not sufficient to know the term of service; the process that produced the corrosion must be understood. (2) The chemical composition is less important than the structure in the effect on the character of the corrosion. (3) Porosity, owing to the surface so presented, plays a decisive part in the speed of corrosion. The character of the corrosion depends on the following conditions: (*a*) the relation existing between the grog and the forming of the refractory (different processes and controls of fabrication have a large influence); (*b*) the relation existing between the chemical compositions in the refractory materials (grain and bond). (4) Testing of sections of the refractories gives valuable data for estimation of the behavior of the product in practice. (5) The resistance of test pieces against corrosion by sodium carbonate at 1000°C is a less satisfactory test than a similar test using sodium sulfate at 1350°C. (6) Analytical study of the quotient SiO_2/Al_2O_3 of the materials of test cubes and of the material taken out by soda treatment under heat demonstrated that for certain refractories there was an enrichment in alumina of the surface of the block which formed a sort of protecting skin. (7) The sodium sulfate test of specimens of blocks indicates less variation of the quotient SiO_2/Al_2O_3 in the specimen after treatment. This process most nearly matches furnace corrosion. (8) The hypothesis of the taking out of Al_2O_3 by alkaline fluxes at high temperatures was not demonstrated and therefore a change in the quotient SiO_2/Al_2O_3 is solely by elimination of the SiO_2. P.E.C.

Erratum. *Rev. belge ind. verrières, céram., émail.*, **3** [9], 212 (1932).—A diagram correction is given for the preceding abstract. P.E.C.

Molding glass-tank refractories. A. MÖSER. *Tonind.-Ztg.*, **57** [62], 722–23 (1933).—Several types of molds are reproduced together with special tools. Practical hints are given for molding large blocks. W.M.C.

Grog brick with a high alumina content. P. P. BUDNIKOFF, A. O. BATT, A. A. GREBENIK, AND V. I. ENDOVITZKIĬ. *Stal*, **3** [1–2], 80–86 (1933); for abstract see *Ceram. Abs.*, **12** [4], 158 (1933). M.V.K.

Influence of grog dust on the chemical and thermal properties of refractory grog brick. P. P. BUDNIKOFF AND E. L. MANDELGRÜN. *Zhur. Prikladnoi Khim.*, **6** [1], 1–11 (1933).—The water absorption and volume porosity of the body decrease with the increase of the grog dust content, while the specific gravity increases. The mechanical strength (resistance to pressure) of the product increases with the increase of the grog dust content. The variation in the grog dust content of the product does not influence the refractoriness and the deformation temperature of the product under load. The thermal stability of the grog product decreases with the increase in the grog dust content. A definite relationship between the ability to withstand slag attack of grog brick and the quantity of grog dust present in it was not determined. The linear expansion of grog brick is directly dependent upon their shrinkage; the greater the shrinkage, the lower is the linear expansion. M.V.K.

Large-scale manufacture of tridymite brick. H. SALMANG AND H. J. LÜNGEN. *Tonind.-Ztg.*, **57** [56], 650–51 (1933).—A number of experiments was carried out with different types of quartzites. Small amounts of a frit were added. The composition of the frit was one part of Na_2O, one part of Fe_2O_3, and two parts of SiO_2. The frit was added to the powdered raw materials. A table shows that several mixtures gave satisfactory results. It is possible to manufacture brick containing tridymite only. These brick show a low porosity and satisfactory resistance against sudden temperature changes. W.M.C.

Physical properties of the B & W 80 Junior fire brick. ANON. *Blast Fur. Steel Plant*, **21** [7], 287–88 (1933); *Fuels & Fur.*, **11** [3], 114 (1933).—The B & W 80 Junior fire brick has a P.C.E. of 33, a melting point at 3175°F, and a shrinkage of only 0.85% after reheating at 2900°F for 5 hr. It showed no deformation under a load of 25 lb./sq. in. at 2660°F and the temperature at which 10% deformation occurred was found to be 2780°F. These high qualities are attributed to the use of a blend of calcined kaolin grog and bond clays. E.J.V.

Bergmans develop new refractory block. ANON. *Nat. Glass Budget*, **49** [15], 3 (1933).—A denser refractory block adapted for use at high temperatures and capable of resisting glass tank fluxing action and its process of manufacture are described. C.H.T.

Perfections and new methods in the construction of ceramic furnaces. G. BAUDRAN. *Rev. mat. constr. trav. pub.*, No. 284, pp. 81–86*B* (1933).—After reviewing causes of the destruction of refractory linings in ceramic furnaces, B. discusses the properties and characteristics of Kestner refractory cements and concretes. Kestner cements are real "hydraulic," basic, and aluminous cements setting with water and hardening in the same way as Portland cement. They are used as mortar (pure cement) or concrete (mixture of cement and crushed silico-aluminous débris or grog). There are two types, (1) refractory cement HT (high temperature, 1100 to 1400°), and (2) refractory cements BT (low temperature, lower than 1250°). These cements support the action of heat and fire without cracking or spalling until they reach the softening and fusing temperature. They are also indifferent to sudden changes of temperature. Their coefficient of dilatation is 5.3×10^{-6}, fusing point 1500°, softening temperature 1400°, and shrinkage 0.5 to 1.5% (according to temperature). Methods for repairing continuous furnaces and Hoffman kilns are described. See also *Ceram. Abs.*, **11** [3], 181 (1932). M.V.K.

Refractory material for cement rotary kilns. J. FAUNER. *Rock Prod.*, **36** [6], 42 (1933).—The effect of mechanical wear, thermal effects, and chemical attack on refractories for cement kilns is discussed. In the upper part of the kiln attention must be given to the abrasion resistance of the block. Thermal effects are important only when starting and stopping the kiln. Chemical attack occurs at the higher temperatures and is more pronounced as the clinkering zone is approached. In the cooler zone, under strongly reducing conditions, CO attacks the iron in the blocks. Also in the hottest zone a strongly reducing flame distills off silica and alkali which are condensed in a cooler part of the kiln with formation of slag. In addition to the alkalis, iron and manganese contribute to any slagging action, and fluorspar, if present, is bad even at 1000°C. With a poor refractory, the presence of slag increases abrasive action considerably, while a thick layer of slag renders the blocks sensitive to temperature changes. The lime in the raw mix is a powerful flux, but the softening of the surface allows the clinker and raw meal to adhere to it with an appreciable protective action. The most satisfactory method of lining the kiln is to lay the block in without mortar, but they must fit properly. Diaspore has given good results in North America, while the Corhart "Electrocast" for the clinkering zone "almost eliminates kiln-lining difficulties." For original reference see *Ceram. Abs.*, **12** [9], 332 (1933). E.J.V.

Refractories for industrial furnaces. VI. Furnace roofs. F. H. NORTON. *Fuels & Fur.*, **11** [2], 54–63 (1933).—Engineering practice in the construction of various types of furnace roofs, including spring arch, dome, suspended arch, and special types, is described. The special types include jack arch, drop arch, ribbed arch, sloping arch, arch with center support, double arch (two layers), perforated arch (with solid arch above), bung arch, and monolithic arch. The materials for use in roofs are considered as affected by furnace conditions. Illustrated. **VII. Construction of furnace walls, hearths, doors, and other parts.** *Ibid.*, **11** [3], 86–96 (1933).—A discussion of modern methods employed in the design and construction of furnace walls, hearths, foundations, and doors is given. Flue and stack construction and the use of checker brick for regenerators are also taken up. The importance of the proper type of iron work is stressed. Illustrated. For Part V see *Ceram. Abs.*, **12** [5], 193–94 (1933). E.J.V.

Monolithic linings for induction furnaces melting nonferrous metals. P. S. KINGSLEY. *Metals & Alloys*, **4** [5], 59–62 (1933).—K. describes in detail the technique of lining an Ajax Wyatt induction furnace with chrome or magnesia cements. In increasing the lining life care must be taken in (1) mixing the cement with water, (2) ramming the cement into place, (3) drying out the lining, and (4) heating the lining. A design for a gas torch for heating the secondary channel is submitted. Illustrated. R.H.H.P., JR.

Refractory materials and the nonferrous industries. A. B. SEARLE. *Jour. Inst. Metals*, **53** [3], xxxix (1933); see also *Ceram. Abs.*, **12** [5], 193 (1933). F.G.H.

Electric furnace refractories. FRANK S. RUSSELL. *Refrac. Jour.*, **9** [7], 247 (1933).—The heat treating of metals by electricity is discussed and an examination of the problems presented by their refractory linings is made for both acid and basic types. C.H.T.

Plant experience with the performance of the refractory lining of the gray cast-iron electric furnace. G. SPER. *Feuerfest*, **9** [1], 4–5 (1933).—S. describes in detail the gradual coating of a furnace with basic materials, dolomite, and magnesite. Tables and diagrams illustrate the article. M.V.K.

Insulation of open-hearth furnaces concerns the refractories man. E. F. ENTWISLE. *Brick Clay Rec.*, **83** [1], 17–18 (1933); *Fuels & Fur.*, **11** [3], 105–10 (1933).—E. discusses the action of the furnace atmosphere and contents on silica brick in insulated and uninsulated roofs, showing that the refractoriness of the insulated brick appears to be improved. The high temperatures deep in the brick resulting from insulation constitute the most dangerous condition arising from insulation. Laboratory tests showing when silica brick should not be heated up are cited. The amount of insulation needed must be based on the minimum thickness the brick finally reaches at the end of the furnace campaign. Insulation performs the purpose of preventing heat radiation and at the same time can be made a most effective preventative of air infiltration. E.J.V.

Observations on the behavior of refractory materials in continuous vertical retorts. A. T. GREEN. *Trans. Ceram. Soc.* [Eng.], **31**, 399–416 (1932); for abstract see *Ceram. Abs.*, **12** [3], 111 (1933). C.H.T.

Standard specifications for stove and hearth linings. ANON. *Tonind.-Ztg.*, **57** [57], 665–66 (1933).—A list is given of the new German standards for the linings of stoves and hearths. W.M.C.

Refractory materials and the gas industry. Progress report. A. T. GREEN. *Gas Jour.*, **202** [3651], 339–42 (1933); for abstract see *Ceram. Abs.*, **12** [9], 331 (1933). G.R.S.

Ceramic investigations of Kurinskii clays. K. KELER. *Trans. State Ceram. Research Inst.* [Moscow], No. 35, pp. 33–51 (1932).—Details of investigations made to determine the ceramic properties of refractory clays from the Kurinskiĭ deposits are given. The results are tabulated. The refractoriness of a series of clays was found to be very high, corresponding to Seger cone 34, 34–35, and 35–36. It was found that these clays do not show definite relationships between the chemical composition, mechanical composition, and their ceramic properties. Elutriating markedly improves the quality of the clays. M.V.K.

Use of Kurinskii clays for the manufacture of refractory grog brick. K. KELER AND V. STRELETZ. *Trans. State Ceram. Research Inst.* [Moscow], No. 35, pp. 51–70 (1932).—A detailed account is given of experiments made with grog brick manufactured from Kurinskiĭ clays. M.V.K.

Management of refractory plants. H. KREMSKI. *Tonind.-Ztg.*, **57** [50], 580–81 (1933). W.M.C.

Progress in the refractory field in the U. S. in 1932. II. W. STEGER. *Feuerfest*, **9** [6], 81–86 (1933); for Part I see *Ceram. Abs.*, **12** [9], 333 (1933). M.V.K.

Occurrence of sillimanite in Assam. CHOUDHURY. *Refrac. Jour.*, **9** [7], 254 (1933).—The location, analysis, and properties of the large quantities of sillimanite recently discovered in the Khasia Hills of Assam are given and its recovery is discussed. C.H.T.

South Wales coking practice and refractories. W. R. D. JONES. *Refrac. Jour.*, **9** [8], 281 (1933).—Service conditions in coke ovens and the properties of silica *vs.* semi-silica linings are discussed. C.H.T.

BOOKS

Specifications and Methods of Test for Refractory Materials and Manual for Interpretation of Refractory Test Data. Prepared by Committee C-8 on Refractories,

American Society for Testing Materials. *Mech. Eng.*, **55** [5], 333 (1933); for review see *Ceram. Abs.*, **12** [1], 24 (1933). F.G.H.

The Silica System, Quartz Ware and Quartz Glass, and Silica Brick. (Das System Kieselerde, Quarzgut und Quarzglas, Silikasteine.) EBERHARD ZSCHIMMER. Ferdinand Enke, Stuttgart, 1933. 146 pp. 37 illustrations. 13.00 Rm. Reviewed in *Glashütte*, **63** [21], 359 (1933).—The book is a compilation of literature dealing with silica and the manufacture of quartz ware, quartz glass, and silica brick. The work discusses (1) the polymorphous modifications of silica (silicon dioxide), its physical properties and conversion, (2) manufacture of quartz ware and quartz glass, its properties and utilization in the chemical industry, and (3) production of silica brick (lime-bonded quartzite brick) and specifications of silica brick for industrial furnaces. M.V.K.

Refractory Masonry for Boiler Houses and Other Important Industrial Furnaces. (Feuerfest Mauerwerk für Dampfkesselfeuerungen und andere wichtige industrielle Öfen.) HÖGANAS-BILLESHOLMS. A/3 Nordiska Bokhandlen, Stockholm. 127 pp. Price 10 K. Reviewed in *Feuerfest*, **9** [6], 91 (1933).—This work is a compilation of researches and observations from practice which should help in the selection of suitable refractory materials. The book treats the following subjects: (1) damages in refractory masonry, (2) precautions for obtaining stability of the masonry, (3) calculation principles for it, and (4) suggestions for measuring refractory brick. A series of interesting tables and graphic representations and explanations of expressions used in the refractory industry is given. M.V.K.

PATENTS

Method of recovering alumina from silicates. F. M. MCCLENAHAN. U. S. 1,918,923, July 18, 1933. A process for the production of alumina comprises preparatorily digesting an aluminous silicate with a fluoride of ammonium to obtain a residue containing aluminum-ammonium fluoride, heating the residue, and treating the residue to remove impurities, the last-mentioned treatment comprising digesting the residue with ammonium sulfate and heating the mass.

Protective lining for a furnace. LEOPOLD TSCHIRKY. U. S. 1,919,048, July 18, 1933. A process of so conditioning and heating up a furnace having a refractory lining as to effect safely an abridgement of the period thereof consists in providing the lining with a temporarily insulating and protective coating of less refractory material than the lining, and applying heat at full rate to the furnace thereby causing the protective coating to disappear.

Control of furnace temperature and furnace-wall construction. F. G. ELY (Fuller Lehigh Co.). U. S. 1,919,324, July 25, 1933.

Furnace. E. A. BROWN, JR., AND WILLIAM S. UNGER. U. S. 1,919,412, July 25, 1933.

Kiln lining. R. W. BURKE. U. S. 1,920,677, Aug. 1, 1933.

Suspended arch for furnaces and tile therefor. C. L. TODD. U. S. 1,921,107, Aug. 8, 1933.

Perforated retainer plate construction for firebrick walls. M. J. CONROY. U. S. 1,921,346, Aug. 8, 1933.

Furnace wall. J. A. SCHRUEFER (Bigelow-Liptak Corp.). U. S. 1,921,843, Aug. 8, 1933.

Furnace-wall construction. J. S. BENNETT (American Engineering Co.). U. S. 1,922,521, Aug. 15, 1933.

Tube for boiler economizers, heat exchangers, etc. R. S. BROWN. U. S. 1,922,351, Aug. 15, 1933.

Furnace construction. J. E. ANDERSON (Plibrico Jointless Firebrick Co.). U. S. 1,922,516, Aug. 15, 1933.

Fastener for fire brick, etc. W. J. GRAVERT. U. S. 1,922,945, Aug. 15, 1933.

Zirconium refractories. J. D. MORGAN (Doherty Research Co.). U. S. 1,923,003, Aug. 15, 1933. The method of making the compound $7ZrO_2 \cdot 2SiO_2$ consists in melting zircon and maintaining the temperature above the fusion point until silica ceases to sublime off the melt.

Process of preparing refractory material. ELISABETH LUX (Koppers Co.). U. S. 1,924,743, Aug. 29, 1933.

Preparation of refractory mortar. ELISABETH LUX (Koppers Co.). U. S. 1,924,744, Aug. 29, 1933.

Checker brick and checkerwork. A. W. SMITH, C. H. HEIST, AND B. M. STUBBLEFIELD. U. S. 1,925,506, Sept. 5, 1933.

Checker brick for blast-furnace stoves or the regenerator chambers of furnaces and

coke ovens. DORMAN, LONG & CO., LTD., AND H. W. OWSTON. Brit. 395,859, Aug. 2, 1933.

Manufacture of silicon carbide bodies. CARBORUNDUM CO., LTD. Brit. 396,088, Aug. 10, 1933.

Melting pots. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 396,420, Aug. 16, 1933.

Fire bridges for boiler furnaces. E. STURROCK. Brit. 397,292, Aug. 30, 1933.

Winning of highly refractory carbides. NAAMLOOZE VENNOOTSCHAP PHILIPS' GLOEILAMPENFABRIEKEN. Brit. 397,372, Aug. 30, 1933.

Method of manufacturing alumina. KALUNITE CO. Brit. 397,409 and 397,411, Aug. 30, 1933.

Refractory articles. L'ÉLECTRO-REFRACTAIRE. Fr. 743,450, March 30, 1933. In casting refractory articles from Al silicate, the molds used are of a material of high heat conductivity and a low coefficient of expansion, *e.g.*, grains of Al silicate or crystalline Al_2O_3 agglomerated with a suitable binder. (*C.A.*)

Refractory and acid-proof compositions. SCHEIDHAUER & GIESSING A.-G. Ger. 573,305, Dec. 20, 1925, and 575,103, April 24, 1933. (*C.A.*)

Alumina. HERMANN WÜNSCHE. Ger. 575,346, April 27, 1933. An alkaline earth aluminate containing SiO_2 is treated with an excess of hot alkali carbonate solution and (after filtering or not, as desired) with CaO or $Ca(OH)_2$ in an amount which is in excess of the amount of free alkali carbonate, the excess of CaO or $Ca(OH)_2$ corresponding to at least 12, preferably 25 to 30, times the SiO_2 content of the solution and being between 6 and 17.5 kg. of CaO per cm. of solution. The solution is then filtered and the $Al(ONa)_3$ solution decomposed with CO_2 in known manner. Al_2O_3 practically free from SiO_2 is obtained. Experimental results are given. (*C.A.*)

Induction furnaces. KARL BEUTHER (Siemens & Halske A.-G.). Ger. 576,085, May 6, 1933. Crucibles and hearths for induction furnaces for melting nonferrous metals are prepared by stamping a moist mixture of sand or like refractory substance with 18 to 25% of powdered glass. (*C.A.*)

Aluminum nitrate. MAX BUCHNER. Ger. 576,159, May 8, 1933. Clay is treated with HNO_3 in an amount below that equivalent to the acid-soluble Al_2O_3 in the clay. Preferably, the reaction mixture is kept at 80 to 100° for some hours and then cooled to nearly 0° before it is filtered. $Al(NO_3)_3$ of low Fe content is recovered from the filtered solution. An example is given. (*C.A.*)

Forming glassmelting crucibles. S. I. KOROLEV AND P. V. BROMLEY. Russ. 28,148, Oct. 17, 1931. Construction details are given. (*C.A.*)

Refractory material. T. R. HAGLUND. Swed. 70,995, Jan. 20, 1931. A material particularly suited for the lining of Martin furnaces, etc., with a total content of not less than 75% of oxides of Mg, Al, and Cr, whereof not less than 5% is Cr_2O_3 and 15% is MgO, and containing less than 12% of SiO_2, is produced by a smelting process. See also *Ceram. Abs.*, **12** [8], 302 (1933). (*C.A.*)

Terra Cotta

Firing stoneware bodies. R. SELZER. *Tonind.-Ztg.*, **57** [58], 676 (1933).—No satisfactory results were obtained by firing stoneware pipe first in an oxidizing atmosphere and then in a reducing one. The ordinary type of firing in a reducing atmosphere gave satisfactory products. Penetration of carbon into the body will increase its softening interval. Formation of bubbles is caused by increasing the temperature too rapidly or by the presence of a very large percentage of fine particles in the body. This may be adjusted by adding grog to the batch. See also article by Grewe, *Ceram. Abs.*, **12** [8], 302 (1933). W.M.C.

Scientific and practical study of principal products for flooring in dwellings. IV and V. F. CHALAMEL. *Rev. mat. constr. trav. pub.*, No. 284, pp. 91–94*B*; No. 285, pp. 110–13*B* (1933).—A discussion is presented of (1) the effect of joints and cracks on germs in fired and unfired products, (2) influence of the products on luminosity in dwellings and the decrease in vitality of Koch bacilli, (3) electrical conductivity of the products, and (4) action of bad weather, fire, water, soluble salts, insects, mushrooms, and parasites. For Part III see *Ceram. Abs.*, **12** [8], 303 (1933). M.V.K.

Defective manufacturing in coarse ceramics. PULFRICH. *Sprechsaal*, **66** [15], 247 (1933).—The field of coarse ceramics is wide (brick, stoneware, etc.). Defects due to manufacturing may be traced to the following causes: (1) *Properties:* Unfavorable properties of raw materials due to injurious constituents, *e.g.*, iron pyrites, lime, gypsum, quartz, soluble salts, and organic substances; (2) *Structure:* dissimilarity of raw ma-

terials and exchange with unsuitable materials; (3) *Preparation:* mistakes with regard to crushing, division, separation, mixing, admixtures (thinning, sintering, stability, color, chemical combination, water); (4) *Molding:* irregular or too low density, effect of the mold (gypsum mold); (5) *Drying:* false length of time, temperature, humidity, flue gases, defective drying strength, too great shrinking (crazing, warping), discoloration (salts, smoke), defective engobing, and glaze adherence; (6) *Firing:* incorrect time, height, atmosphere, unequal temperature distribution, defective firing strength, too great shrinkage, swelling, melting, firing and cooling flaws, bursting, discoloration, defective engobes, and glazes. Visible or perceptible defects may be recognized through the shape, color, surface, strength, luster, structure, or flaws. Invisible defects are detected through thorough testing. M.V.K.

Straight ridge tile. ANON. *Tonind.-Ztg.*, **57** [52], 608–609 (1933).—New types of ridge tile are shown. They look better than the ordinary ones and are easy to manufacture. Illustrations show their use in roofing. W.M.C.

Sorting roofing tile. ANON. *Tonind.-Ztg.*, **57** [60], 700 (1933).—Three grades of roofing tile are recognized in Germany. Some practical hints are given for a more efficient sorting. W.M.C.

Terra cotta chosen for President's pool. ANON. *Ceram. Age*, **22** [1], 10–11 (1933).—The terra cotta construction of President Franklin D. Roosevelt's private swimming pool in the White House is described and illustrated. F.G.H.

Fifth International Builders Exposition. RAYMOND RIEZ. *Rev. belge ind. verrières, céram., émail.*, **4** [3], 49–51 (1933).—This occurred in Brussels, January, 1933. Numerous papers were presented and modern trends noted and studied both in architecture and materials. P.E.C.

BOOK

Weathering of Stone Buildings. Its Cause and Prevention. A. KIESLINGER. Verlagsgesellschaft F. Deuticke, Leipzig and Wien, 1932. Reviewed in *Mineralog. petrog. Mitt.*, **44** [1], 83–84 (1933). G.R.S.

PATENT

Machine for truing tile. A. HAPPEL (U. S. Quarry Tile Co.). U. S. 1,920,076, July 25, 1933.

White Wares

Effect of organic grinding media on water-soluble silica frits. H. B. BARLETT AND KARL SCHWARTZWALDER. *Jour. Amer. Ceram. Soc.*, **16** [9], 452–54 (1933).

Microstructure of electrical porcelain glazes. HOBART M. KRANER. *Ceram. Ind.*, **21** [2], 73–75 (1933).—It has been found that different standard glazes used for electrical porcelain cause variations of as much as 50% of the tensile strength of the porcelain in tension. A microscopic study of a number of different glazes showed that in many there are cloudy appearances representing extremely fine undissolved particles which give opacity and color, in others there are large particles of quartz, while in others there are large bubbles representing the evolution of adsorbed glasses from the batch during melting. The glazes consisting largely of Albany slip generally show less undissolved material, bubbles, and evidence of recrystallization than other glazes. Photomicrographs show that many of the commercial glazes are not glasses as they are ordinarily considered, and the so-called mahogany Albany slip glazes seem to be the nearest approach to a perfect glassy coating that is available. Illustrated. E.J.V.

Nature of glass in porcelain bodies. SEIJI KONDO AND KESAKICHI MOTEKI. *Jour. Soc. Chem. Ind.* [Japan], **36** [4], 169*B* (1933).—The microstructure of different porcelain bodies is discussed. M.V.K.

X-ray study of porcelains and their relation to mullite. A. J. BRADLEY AND A. L. ROUSSIN. *Trans. Ceram. Soc.* [Eng.], **31**, 422–30 (1932).—Powder photographs of some porcelains were compared with those of the minerals sillimanite, mullite, and related minerals. Kaolinite occurs in three forms, kaolinite, dickite, and nacrite. The name "porzite" is suggested for the essential constituent of porcelain having a structure different than either sillimanite or mullite. Illustrated. C.H.T.

Effect of electrolytes on clay slips. F. L. CLARK. *Trans. Ceram. Soc.* [Eng.], **32** [1], 1–6 (1933).—The effect of small additions of sodium silicate on the deflocculation and viscosity of slips, plasticity of the casting, and on casting and drying time can be pre-

dicted by adhesion-tension relationships. Experimental evidence in support of theoretical conclusions is given. C.H.T.

Electric strength and crystal structure. A. v. HIPPEL. *Z. Physik*, **75**, 145–70 (1932); see following abstract. (*C.A.*)

The paper by v. Hippel, "Electric strength and crystal structure." ALEXANDER WALTHER. *Z. Physik*, **77**, 275–76 (1932); see following abstract. (*C.A.*)

Critical remarks concerning the breakdown of some solid insulators. L. INGE, A. WALTHER, AND B. VUL. *Physik. Z. Sowjetunion*, **3**, 284–303 (1933).—Discussing principally the work of Hippel, Sinelnikov, and co-workers, the authors conclude that the present theories of (1) the rupture of crystal lattice, (2) removal of electrons, and (3) impact ionization do not adequately explain the experimental facts. They also show that growth of dendrites within the crystal does not precede electric breakdown and has nothing to do with heat breakdown. (*C.A.*)

Physical chemistry in porcelain manufacture. WILLARD J. SUTTON. *Lingnan Sci. Jour.*, **12**, Supp. 65–78 (1933).—Phase-rule diagrams show composition, maximum resistance areas (dielectric, mechanical, and thermal), softening temperatures, and mineralogical constituents of porcelains and related substances. The importance of mullite ($3Al_2O_3 \cdot 2SiO_2$) and the decomposition of sillimanite ($Al_2O_3 \cdot SiO_2$) into mullite and tridymite before 1300° are emphasized. Porcelains with a high mullite content and a minimum of undissolved quartz grains have the best mechanical properties and resistance to heat, thermal change, and electric conductance. (*C.A.*)

Die filling, hardness, and wedging of dust-pressed tile. HARRY W. WEBB. *Trans. Ceram. Soc.* [Eng.], **32** [5], 218–46 (1933).—The penetration hardness of porous bodies was investigated by means of a hardness machine, which is described, and a relationship established between depth of penetration, porosity, and tensile strength. The filling of tile dies causes characteristic irregularities from which six types of wedging of different magnitudes can be obtained. Increased moisture content is shown to increase hardness, to obtain greater evenness of vitrification, and to diminish wedging. Increase in moisture content above the critical value for a given pressure results in a more porous tile and uneven vitrification. The dust undergoes no plastic flow in the die, and the density and pressure gradients in the pressed tile follow the ordinary physical laws governing dust pressing. The conversion of a plastic body into dust appears to cause uneven vitrification, possibly through segregation of the constituents. The composition of bodies least liable to wedge is discussed. Placing methods have a considerable influence on the extent of wedging and the most favorable is shown. Increased pressure of making, up to a critical value, diminishes the extent of wedging. Illustrated. See also *Ceram. Abs.*, **12** [7], 270 (1933). C.H.T.

Behavior of insulator porcelain under permanent stresses. F. NEUMANN. *Sprechsaal*, **66** [20], 333–34 (1933).—Not only should the porcelain be of the highest quality with regard to mechanical strength but also special care should be taken that the whole structure of the separate elements of the insulator does not produce additional stresses. The glaze does not only increase the strength but tends to adjust the effect of the damages on the surface. References of researches made on the subject are given. M.V.K.

Using cyanite in the Russian ceramic industry. A. LULKI. *Sprechsaal*, **66** [24], 403–405 (1933).—Attempts to use cyanite in the manufacture of porcelain and refractory materials are described. From 30 to 50% of fired cyanite added to the porcelain mix increases (1) its mechanical strength, (2) dielectric properties at normal and high temperatures, (3) resistivity to chemical reagents at high temperatures, (4) refractoriness, (5) resistivity to sudden temperature changes, and (6) thermal resistivity. In refractory materials, cyanite increases the mechanical and chemical resistance and resistivity to the attack of slag. The coefficient of expansion of refractories containing cyanite amounts to 5.6×10^{-6} between 20 and 1000°. The resistance to slag was considerably higher than that of grog brick at 1450°. Data on the composition of porcelain and refractory brick containing cyanite are given. M.V.K.

Pyrometer guard tubes. G. KEINATH. *Arch. tech. Mess.*, **2**, T185 (Dec., 1932).—Pyrometer guard tubes are considered from the standpoint of gas-tightness, heat conductivity, resistance to shock and abrupt changes of temperature, ability to withstand elevated temperatures, and vapors evolved from the tube itself which might harm the pyrometer. The field of usefulness of a number of ceramic and fused materials, metals, and alloys is indicated. Consideration is also given to the use of double guard tubes of two different materials. (*Rev. Sci. Inst.*)

Manufacturing defects, their cause and prevention in the porcelain industry. R. RIEKE. *Sprechsaal*, **66** [15], 248 (1933).—A review of defects due to (1) preparation of

the mix, (2) wrong raw materials, (3) erroneous grinding fineness, (4) mixing, (5) faulty slip, (6) defective molding, (7) defects when glazing, and (8) defects due to firing is discussed in detail. M.V.K.

Data. XVIII. T. W. GARVE. *Clay-Worker*, **100** [1], 18–19 (1933).—G. gives definitions, methods of manufacture, and properties of pottery, stoneware, earthenware, both coarse and fine, porcelain, and china. For Part XVII see *Ceram. Abs.*, **12** [9], 343 (1933). E.J.V.

American high-tension porcelain. LUDWIG ERNST THIESS. *Sprechsaal*, **66** [19], 317–19 (1933).—American high-tension porcelain, its composition, manufacture, and physical properties are discussed. Considerable differences between the German hard porcelain and the American material fired at a lower temperature are noted. M.V.K.

What should be the body of sanitary faience? V. N. STEFANOVSKAYA. *Keram. i Steklo*, **9** [5], 11 (1933).—Comparisons between the structure and properties of bodies of American and Russian sanitary faience are given. M.V.K.

Germany introduces new ceramic insulating materials. HERMSDORF SCHOMBURG ISOLATOREN GESELLSCHAFT. *Ceram. Ind.*, **21** [2], 75 (1933); for abstract see article by Wallich, *Ceram. Abs.*, **12** [9], 334 (1933). E.J.V.

Technical progress in fine ceramics in 1932. W. STEGER. *Keram. Rund.*, **41** [5], 55–58; [6], 68–70; [7], 84–87; [8], 99–100 (1933).—The article deals with (1) ceramic raw materials, (2) preparation, shaping, and apparatus used, (3) drying and drying installations, (4) firing and furnaces, (5) measuring, investigating, and testing methods, (6) standardizing, (7) ceramic mixes, (8) glazes, (9) decorating, and (10) special branches of ceramics. References from American, English, and German literature dealing with the subject are given. M.V.K.

Critical notes on literature dealing with the history of the discovery of porcelain in Europe. W. FUNK. *Keram. Rund.*, **41** [11], 131–34; [12], 149–52; [13], 161–63 (1933).—German literature on the history of porcelain is discussed. M.V.K.

Constitution and fabrication of porcelain. LÉON FRANCQ. *Rev. belge ind. verrières, céram., émail.*, **3** [10], 224–27 (1932); **4** [5], 100–104 (1933).—F. compiles, after a brief history of the development of porcelain in Europe, a tabulation of properties, sources, etc., of raw materials and finished products from the point of view of Continental porcelain production. P.E.C.

PATENTS

Expansion joint for tiled bathtub recesses. W. G. ANDERSON. U. S. 1,919,354. July 25, 1933.

Tile machinery. A. C. MYERS (Kraftile Co.). U. S. 1,919,639, July 25, 1933.

Tile fabricating machinery. A. C. MYERS (Kraftile Co.). U. S. 1,919,640, July 25, 1933.

Electric water closet. J. C. DUNER. U. S. 1,920,367, Aug. 1, 1933.

Water-closet bowl and clean-out construction therefor. SAMUEL KRINSKY. U. S. 1,922,961, Aug. 15, 1933.

Testing apparatus and method. A. O. AUSTIN (Ohio Brass Co.). U. S. 1,923,565, Aug. 22, 1933.

Process for forming plastic clay masses. D. H. ROWLAND AND KURT WETZEL (Locke Insulator Corp.). U. S. 1,925,058, Aug. 29, 1933. In the manufacture of ceramic ware, the steps of deflocculating a clay slip to increase its fluidity, reflocculating it to restore its plasticity, and blunging it to effect shaping are described.

Lavatory basins. A. REYROLLE & CO., LTD., ADAMSEZ, LTD., H. W. MILLER, AND A. H. ADAMS. Brit. 395,768, Aug. 2, 1933.

Combined insulators and holders for suspended electric lamps. DEUTSCHE TON & STEINZEUGWERKE AKT.-GES. Brit. 395,922, Aug. 2, 1933.

Manufacture of ceramic earthenware, etc. RAINFORD POTTERIES, LTD., AND F. W. GRUNDY. Brit. 396,349, Aug. 10, 1933.

Manufacture of pottery ware. W. BLOCH. Brit. 396,532, Aug. 16, 1933.

Teapots, coffeepots, hot water jugs, etc. J. HILL. Brit. 396,773, Aug. 23, 1933.

Ceramic liquid resistance. PORZELLANFABRIK KAHLA. Brit. 397,349, Aug. 30, 1933.

Joining metal parts to ceramic articles. SIEMENS-SCHUCKERTWERKE A.-G. Ger. 577,128, May 24, 1933. The ceramic article is coated with a siliceous glaze and fired, and a thin metal coating is then applied, *e.g.*, by brushing on a suspension of Pt and Bi or their chlorides in an ethereal oil and heating the article to 400 to 800°. The metal coating is then strengthened, *e.g.*, by dipping the article in fused Sn and Pb, and finally the metal part is affixed, *e.g.*, by welding or soldering. (*C.A.*)

Equipment and Apparatus

Permissible curvature of prism surfaces and inaccuracy of collimation in precise minimum-deviation refractometry. L. W. TILTON. Bur. Stand. *Jour. Research*, **11** [1], 25–57 (1933); R.P. 575.—Tolerances, corresponding to an error of $\pm 1 \times 10^{-6}$ in index of refraction, are evaluated for curvature of prism surfaces, translational adjustment of the prism, eccentricity of prism-table axis, and collimator refocusing. R.A.H.

Determination of the space-lattice of a triclinic mineral by means of the Weissenberg X-ray goniometer. G. TUNELL. *Amer. Mineralogist*, **18** [5], 181–86 (1933).—The steps in an analysis with the Weissenberg goniometer are discussed and its advantages in obtaining data for triclinic crystals are pointed out. G.R.S.

Precision measurements of lattice constants by means of the back-reflection method. H. MÖLLER. *Stahl Eisen*, **53** [25], 655–56 (1933).—This X-ray method has been used in determining the solubility of mixed crystals and in detecting the presence of internal strain. Its accuracy is based on the fact that the sine of an angle will change very little close to 90°. Instead of measuring the distance between the sample and the film, the distance should be calculated from the constants of known comparison samples. The temperature of the sample will influence the results. Care should be taken, therefore, that the sample and the standard are examined at the same temperature. W.M.C.

Photographic recording of sedimentation curves. G. GOLLNOW. *Tonind.-Ztg.*, **57** [55], 643 (1933).—A tube containing the substance to be investigated is placed into the apparatus. A beam of light passes through a couple of slits and the test tube. The change of the height of the substance is recorded on photographic paper mounted on a rotating drum. No lenses, etc., are used. W.M.C.

Method for precipitation of emery in a tube and the photomicrographic examination of the particles. A. V. SHUBNIKOV. *Mineral. Suir'e*, **7** [2–3–4], 52–59 (1932). (*C.A.*)

Aging of nickel-chrome-nickel thermoelements. A. GRUNERT. *Chem. Fabrik*, **6**, 39–40 (1933).—Experiments carried out over a period of 100 to 150 hr. show that vacuum-fused wires of nickel and chrome-nickel of a diameter of 1.6 mm. and 3 mm. record uniformly temperatures of 1100 to 1300°C. The materials for the wires were taken from different charges and their ages differed by about a year. These results were confirmed by use in actual furnace operation for 6 to 8 months at 1000 to 1100°C with a deviation not exceeding ±12°. Heating to 700 to 1200° and subsequent slow cooling in air or rapid cooling in water effected a maximum change in recording of 3°. A slight increase of chromium contents, however, changed the thermal force by 1.9 millivolts which amounts to 48° in the given case; impurities of foreign elements such as Mn, Si, and Al also exert considerable influence. J.G.T.

Mean temperature difference and heat transfer coefficient in liquid heat exchangers. A. P. COLBURN. *Ind. Eng. Chem.*, **25** [8], 873–77 (1933).—Where the overall coefficient of heat transfer, U, varies throughout a heat exchanger, the calculation of heat transfer by use of the logarithmic mean temperature difference may lead to considerable error. For the special case where U is a linear function of temperature, the simple relationship has been derived that the heat transfer rate is equal to the logarithmic mean of $U_1 \Delta t_2$ and $U_2 \Delta t_2$, the subscripts indicating terminal conditions. A family of curves is also provided for this case which indicates the temperature to be used with the heat transfer coefficient calculated by a logarithmic mean temperature difference. Two detailed examples illustrate the application of these procedures. F.G.H.

Flow of fluids in closed conduits. R. J. S. PIGOTT. *Mech. Eng.*, **55** [8], 497–515 (1933).—Illustrated with graphs. F.G.H.

Thermal expansion of heat-resisting iron alloys. J. B. AUSTIN AND R. H. H. PIERCE, JR. *Ind. Eng. Chem.*, **25** [7], 776–79 (1933). F.G.H.

Curved-tube manometer. ANON. *Chem. & Ind.*, **52** [28], 581 (1933).—Descriptions and applications are given of notable designs of Pitot tubes and orifice meters. Illustrated. C.H.T.

Partial radiation pyrometer. A. KARSTEN. *Rev. belge ind. verrières, céram., émail.*, **3** [3], 57 (1932).—A diagram shows the construction of the instrument and descriptive matter explains the workings. It is not necessary to measure the current needed to heat the filaments, thus giving a self-contained tool. P.E.C.

Pyrometric economies. W. BOWEN. *Gas Jour.*, **203** [3659], 48 (1933).—A new thermocouple, called "pyrofer," is composed of two wires, one of which possesses extraordinary heat-resisting properties which are even more outstanding than those of nichrome. Temperatures as high as 1450°C have been measured without harm to the elements. A new resistance coil is also described. G.R.S.

Modern slide rule. H. O. COOPER. *Engineer*, **153** [3988], 658–59 (1932).—The slide rule considered is fitted with the usual A, B, C, and D scales and log-log-scale, and it may have scales for voltage drop and efficiencies of dynamos and motors. In addition, the newer slide rules carry a reciprocal scale and a scale of cubes. F.G.H.

Hardness values for electrochemical products. R. R. RIDGWAY, A. H. BALLARD, AND B. L. BAILEY. *Trans. Electrochem. Soc.*, Preprint 63–27, 267–90 (1933).—The following methods of determining the relative hardness of electrochemical materials which exceed the range of ordinary testing machines are described: (1) hand scratching, (2) standardized points and plates using constant pressure, (3) diamond-point scratching, (4) Rockwell tests, and (5) impact abrasion hardness by means of a standard sand-blast machine. Significant results obtained by each method are tabulated. An extension of Moh's scale is suggested. R.H.H.P., JR.

Influence of inlet boxes on the performance of induced-draft fans. T. S. MARKS AND E. A. WINZENBURGER. *Fuels & Steam Power*, **54**, 16 (1932); abstracted in *Mech. Eng.*, **55** [7], 452 (1933).—The authors present experimental results of tests to determine the effect of inlet boxes on the performance of induced-draft fans. The tests indicate the magnitude of the changes in performance that can be expected and emphasize the need for testing fans with their inlet boxes attached. F.G.H.

Purification of gases influenced by strength of the electric field and by the time of remaining in the electric filter. S. KALASCHNIKOW. *Z. tech. Physik*, **14** [7], 267–70 (1933).—K. studied the influence of strength of the electric field, axial velocity of the gas, and dimensions of the filter. The purification was found to be in satisfactory agreement with the theory developed by Deutsch (*ibid.*, **6**, 423 (1925)). The conclusion is drawn that no additional phenomena occur in electric filters. W.M.C.

All metal gas analyzer. KARL MUNZER. *Eng. Progress*, **14** [4], 71–74 (1933).—A new gas analyzer which records and indicates CO_2 and unburned gases is described. Illustrated. J.L.G.

Gas measurement practice in Europe. ANON. *Gas Jour.*, **202** [3658], 918–20 (1933).—A comparison is made with American methods. Three types of gas meters most extensively used are discussed. The venturi tube, ring balance, and indicating float gage are dealt with. G.R.S.

Drying clay products. T. W. GARVE, ELLIS LOVEJOY, AND W. D. RICHARDSON. *Clay-Worker*, **100** [1], 12–14 (1933).—A discussion of some of the disputed points brought up in Richardson's previous article (*Ceram. Abs.*, **12** [9], 335 (1933)) is presented. Illustrated. E.J.V.

Waste-heat tunnel driers. W. D. RICHARDSON. *Clay-Worker*, **100** [2], 56 (1933).—The introduction of hot air into the bottom of the tunnel is described as being more logical than introducing it at the top. C.H.T.

Theory of artificial drying, calculating the characteristic element, thermal balance, and control of an artificial drying installation. G. BARBEROT. *Rev. mat. constr. trav. pub.*, No. 285, pp. 101–104*B*; No. 286, p. 138*B* (1933). M.V.K.

Construction of drying plants. W. GIECHE. *Tonind.-Ztg.*, **57** [55], 641–42 (1933). W.M.C.

Drying equipment for ceramic products. J. SCHMARJE. *Z. Ver. deut. Ing.*, **77** [29], 809 (1933).—Modern continuously operating machines for drying ceramic ware are described. Diagrams of the machines and plant design are included. L.T.B.

Crushing rolls with axial movement. M. BARBEROT. *Brit. Clayworker*, **42** [495], 112–13 (1933).—A mathematical explanation is given of the operation of crushing rolls with axial movement to demonstrate their advantages over ordinary crushing rolls. Advantages of the former over the latter are claimed to be as follows: (1) They effect a tearing of the clay in the longitudinal direction. (2) They effect a better grinding of hard bodies because the axial movement of the rolls causes the nodule of clay to pivot on itself until some roughness comes in contact with it and the angle of friction becomes sufficient so that the lump becomes crushed. (3) Regular wear of the roll cylinders takes place over their whole surface, improving the output and prolonging the life. See also *Ceram. Abs.*, **12** [7], 271 (1933). R.A.H.

Horizontal mills and mills with propulsion cylinders. I and II. PIERRE RENAULT. *Rev. mat. constr. trav. pub.*, No. 284, pp. 95–99*B*; No. 285, pp. 113–17*B* (1933).—Different types of French mills are discussed. M.V.K.

Collecting dust from grinders. H. F. LORING. *Popular Sci. Monthly*, **122** [6], 60 (1933).—A practical dust exhauster is described and illustrated. F.G.H.

Recent advances in the design of rotary air-compressors. M. LACKMAN. *Eng. Progress*, **14** [4], 65–67 (1933).—The new styles are of the multicell type with crescent-

shaped air space. A runner ring revolving with the rotor and supported by the casing replaces the older floating ring construction. J.L.G.

Calculating the output of air separators. C. NASKE. *Tonind.-Ztg.*, **57** [59], 684–86 (1933).—The application of formulas developed by different writers is demonstrated, and the output of some separators is calculated. W.M.C.

Use of "Ter Meer" type of centrifugal separators in salt works. R. W. MILLER. *Chem. & Ind.*, **52** [17], 368–70 (1933).—Examples of extracting fluids from solids and drying the latter are given. Illustrated with diagrams and photographs. G.R.S.

Wide-range variable gas flowmeter. B. W. BRADFORD. *Chem. & Ind.*, **52** [17], 363–64 (1933).—By employing a variable choke tube, which is described, and working with a constant pressure difference between the two sides of the orifice, an instrument was evolved having a linear scale throughout a greatly extended range of flow rates and with a corresponding improved sensitivity at low rates of flow. Illustrated. G.R.S.

Water determination apparatus of Wefelscheid. W. GURR. *Sprechsaal*, **66** [20], 338 (1933).—Methods for determining the water content in ceramic raw materials are reviewed and their defects pointed out. A new apparatus permitting exact measurements is described. Illustrated. M.V.K.

Lubricating clay dies electrically. J. O. EVERHART. *Ceram. Age*, **21** [6], 177 (1933).—A brief description of the electrical lubrication of clay dies is given. The results obtained in several commercial installations are described. An extensive study of the following fundamentals is being made at the O.S.U. Engineering Experiment Station: (1) permissible voltages, (2) moisture contact, (3) thickness of ware, (4) use of electrolytes, (5) heating effect, and (6) insulation material. See also *Ceram. Abs.*, **12** [6], 236 (1933). F.G.H.

Extruding machines. E. POLLACK. *Tonind.-Ztg.*, **57** [65], 757–58 (1933).—Substituting new extruding machines for old ones results in a great economy because of recent developments in these machines. W.M.C.

Repairing the blades of extruding machines. ANON. *Tonind.-Ztg.*, **57** [51], 593 (1933). W.M.C.

Uses of the sandblast. ANON. *Eng. Progress*, **14** [3], 59–60 (1933).—Sandblasting is used in the glass industry for matting the surfaces of plate glass and hollow glass and for producing stencil designs. It is also used in carving in low relief, in cleaning castings and sheet metal, for cleaning files, graining zincograph plates, removing the hardening scale from tools, and for partially or completely matting high-class gold, silver, and steel ware. Illustrated. J.L.G.

Reflectors and first surface mirrors manufactured by new pancro process. ANON. *Nat. Glass Budget*, **49** [17], 3 (1933).—An alloy of noncorrosive metals is described as having a light gain of 50% or more over silver and a coefficient of reflection up to 96% in all color bands throughout the visible spectrum and 85% in the ultra-violet. C.H.T.

Dry preparation of raw kaolin. O. KRAUSE AND ALFRED LAUBENHEIMER. *Sprechsaal*, **66** [23], 387–88 (1933).—Apparatus employed with success in Russia for the dry preparation of raw kaolin is described. M.V.K.

Crucible furnace. ANON. *Gas Jour.*, **202** [3656], 806 (1933).—A diagram shows the construction of the furnace. The air is preheated by external and internal recuperators. The method of working and tables on efficiency tests are given. G.R.S.

Excavators for the clayworker. W. BARNES AND A. H. WADE. *Trans. Ceram. Soc.* [Eng.], **32** [4], 147–66 (1933).—Notes are given on excavating problems, and machine selection is discussed with regard to (1) raw material, (2) output, (3) working depth, (4) mixing, (5) separation of stones, (6) overburden, and (7) capacity of wagons. Illustrated. C.H.T.

Two thousand tons excavated every hour. ANON. *Eng. Progress*, **14** [4], 77–78 (1933).—A bucket-chain excavator in a Rhineland colliery for stripping the overburden and discharging it into trucks has an overall length of 250 ft., and the height of the ladder above the rail is 86 ft. The bucket chain is driven by an 820-h.p. motor. An excavating depth of 66 ft. or greater can be reached depending on the angle at which it is possible to set the ladder. Illustrated. J.L.G.

Right metal for the right job. C. E. BALES. *Brick Clay Rec.*, **83** [1], 22–23 (1933); for abstract see *Ceram. Abs.*, **12** [7], 272 (1933). E.J.V.

BOOKS AND BULLETIN

Mechanical Testing. Vol. I. Testing of Materials of Construction. R. G. BATSON AND J. H. HYDE. E. P. Dutton and Co., New York, 1932. 2d ed. 465 pp. Price $6.50. Reviewed in *Mech. Eng.*, **55** [4], 270 (1933). F.G.H.

Fan Engineering. R. D. MADISON AND W. H. CARRIER. 3rd ed. Buffalo Forge

Co., Buffalo, N. Y. 622 pp. Price $3.00. *Mining & Met.*, **14** [320], 354 (1933).—A convenient collection of numerical and technical data frequently wanted by fan users is presented. Part I discusses the general physics of air and the matter of air flow. Part II deals with the uses of fans for air conditioning, heating, drying, combustion, dust removal, and other industrial purposes. The final section discusses the selection of fans and gives performance tables, dimensions, and other information concerning products of the publisher. E.J.V.

Gas Analysis by Measurement of Thermal Conductivity. H. A. DAYNES. Cambridge University Press, 1933. 357 pp. Reviewed in *Gas Jour.*, **202** [3654], 613 (1933).—The general principles of the thermal conductivity of gases in relation to their composition, and also the hot wire conductivity bridge are dealt with in early chapters. Much space is devoted to special forms of instruments including the Shakespear, Bureau of Standards, Leeds and Northrup, Siemens and Halske, and Engelhard types. Other topics are the merits of different types of resistance bridges, the time-lag factor and sensitivity, and methods of calibration. Special applications are treated in the last two chapters. G.R.S.

Chemical Engineering and Chemical Catalogue. Edited by D. M. NEWITT. 9th ed. Leonard Hill, Ltd., London, 1933. Price 10s. Reviewed in *Engineering*, **135**, 713 (1933). H.H.S.

The Chemical Engineer. Vol. I. Physical Working Processes of Industry. Vol. II. Physical Control and Regulation of Industry. (Der Chemie-Ingenieur. Band I. Physikalische Arbeitsprozesse des Betriebes. Band II. Physikalische Kontrolle und Regulierung des Betriebe.) Edited by A. EUKEN AND M. JACOB. Akademische Verlagsgesellschaft, Leipzig, 1933. Reviewed in *Chem. & Ind.*, **52** [18], 395; [29], 605 (1933); *Ind. Eng. Chem.*, **25** [6], 714 (1933).—The fundamental laws of heat flow by conduction, convection, and radiation are excellently presented in Vol. I. Heat flow through gases and liquids under different conditions of flow, temperature, and pressure is discussed. Data on heat transfer coefficients of various insulating materials and materials of construction are included. Volume II describes recording, intermittent, continuous, automatic, remote controlled, and other types of instruments, and their uses and applications in various industries are given. Accuracies and limitations are discussed and methods of testing as well as care of the instruments are included. F.G.H.

Fundamental Laws of Heat Transmission. (Die Grundgesetze der Wärmeübertragung.) H. GROBER AND S. ERK. Julius Springer, Berlin, 1933. 2d ed. 259 pp. Price 22.50 Rm. *Mech. Eng.*, **55** [5], 331 (1933).—A systematic collective account of the whole field of heat conduction and heat transfer is presented. The first section presents the analytical theory of heat conduction, the second discusses the movement of heat in liquids, and radiation is treated in the third. A collection of useful numerical tables is appended. F.G.H.

Heavy-duty vibrating screen. PRODUCTIVE EQUIPMENT CORP. 4 pp. Reviewed in *Ceram. Age*, **21** [6], 186 (1933).—An eccentric vibrating screen suitable for the dry, damp, or wet screening of heavy materials is described and illustrated. F.G.H.

PATENTS

High-temperature furnace. G. B. REMMEY. U. S. 1,879,494, Sept. 27, 1932.

Method of and apparatus for separating solid carbonaceous material from foreign impurities. CLIFFORD MACHEN. U. S. 1,905,945, April 25, 1933.

Continuous indicating viscosity gage. L. R. ANDERSON AND H. E. PENGILLY. U. S. 1,919,921, July 25, 1933.

Safety curtain for presses. R. A. SHAW. U. S. 1,919,868, July 25, 1933.

Optical pyrometer. EARNSHAW COOK AND E. L. ANDERSON (Bethlehem Steel Co.). U. S. 1,920,293, Aug. 1, 1933. In an optical pyrometer of the disappearing filament type, a Wheatstone bridge comprises a branch containing a standard lamp and a low fixed resistance, a second branch consisting of a very high fixed resistance and one or more variable resistances having moving contacts, the total resistance of the second branch being substantially higher than that of the first branch, and scales associated with the moving contact of one of the variable resistances calibrated in terms of temperature.

Method of making a ceramic container. W. E. BOCKMON. U. S. 1,920,459, Aug. 1, 1933. In a method of making ceramic containers and receptacles from plastic clay compositions, the steps of compressing the plastic material at vertically spaced substantially horizontal zones during the molding of walls of receptacles to form relatively dense wall portions spaced by relatively porous wall portions, the relatively porous wall portions being subjected to lower pressure during the molding than the compressed portions, and then drying and firing the molded receptacles are described.

Ball-mill lining. F. L. HAUSHALTER (B. F. Goodrich Co.). U. S. 1,921,672, Aug. 8, 1933.

Machine for molding and pressing brick or blocks. C. M. EBERLING. U. S. 1,922,474, Aug. 15, 1933.

Holder for brick, etc. W. P. SULLIVAN. U. S. 1,922,560, Aug. 15, 1933.

Brick press. R. B. STUCKEY (W. A. Riddell Co.). U. S. 1,925,416, Sept. 5, 1933.

Vibratory screen. W. L. KEEFER (H. G. Wolf). U. S. 1,925,447, Sept. 5, 1933.

Tile-testing machine. H. A. B. GOODALL AND F. B. CRAMER. U. S. 1,925,718, Sept. 5, 1933.

Racks for drying plates, etc. C. M. D.-H. IRVING. Brit. 395,054, July 19, 1933.

Testing apparatus for spark plugs of internal combustion engines. A. DURST. Brit. 395,531, July 26, 1933.

Manufacture of pottery ware. W. J. MILLER. Brit. 395,855, Aug. 2, 1933.

Control of volumetric output and discharge pressure of fans, blowers, and pumps of the centrifugal and propeller types by modification of the intake conditions. T. B. COLLINS. Brit. 395,874, Aug. 2, 1933.

Machine for pressing semiplastic or plastic materials in the manufacture of brick, tile, etc. CLAYTON, GOODFELLOW, & CO., LTD., AND T. WHITTAKER. Brit. 395,986, Aug. 2, 1933.

Machines for sizing, grading, or classifying. W. H. BERRISFORD. Brit. 396,807, Aug. 23, 1933.

Apparatus for grading materials into different sizes. J. A. COOK. Brit. 396,748, Aug. 23, 1933.

Apparatus for separating clay, etc., from carbonaceous materials. BRITISH COAL DISTILLATION, LTD. Fr. 742,678, March 14, 1933. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Fundamentals and economies in the clay industries. XXIX. ELLIS LOVEJOY. *Clay-Worker*, **100** [1], 16–17 (1933).—The various reasons for the lag in the development of rectangular downdraft kilns are enumerated. The several types of rectangular kilns as they have been developed are discussed, showing the final design to be the two stack balanced-draft kiln. Fundamental dimensions generally accepted by engineers are listed as are some advantages of the rectangular kiln over the round kiln. Illustrated. For Part XXVIII see *Ceram. Abs.*, **12** [9], 337 (1933). E.J.V.

Note on progress with W. D. circular tunnel kilns. ARTHUR N. TARRANT. *Refrac. Jour.*, **9** [5], 179 (1933).—A new circular tunnel kiln is described and its advantages and operation are discussed. Illustrated. C.H.T.

Tunnel kilns for firing refractory products. W. E. GIBBONS. *Refrac. Jour.*, **9** [5], 176 (1933).—A tunnel kiln is described and the application of tunnel kiln firing to refractories is discussed. Illustrated. C.H.T.

Firing of refractories. W. J. REES. *Refrac. Jour.*, **9** [5], 175 (1933).—The complex nature of the clay as a mineral necessitates a proper firing schedule and pyrometric control. C.H.T.

Method of study of the Hoffman furnace applied to a part of the circuit. R. MOREL-D'ARLEUX. *Céramique*, No. 536, pp. 237–42 (1932).—The heat balance of a Hoffman furnace is discussed with calculations showing the proportion of heat utilized for the evaporation of moisture, for warming the brick, as waste in stack gases, etc. M.H.B.

Firing high-grade ware in Hoffman kilns. ANON. *Brit. Clayworker*, **42** [492], 135–36 (1933).—The most recent improvement in the setting of fire channels of the Hoffman kiln was devised to minimize the damage caused by the contact of the ware with the burning coal. Illustrations are given of the method of setting the brick in the kiln. R.A.H.

Are one or several dampers to be opened in firing the ring kiln? P. THOR. *Tonind.-Ztg.*, **57** [57], 663 (1933).—Under ordinary conditions, only one damper should be used. The dimensions of each damper of the kiln should therefore be large enough to take care of all the flue gases. W.M.C.

Use of a ring kiln as a periodic kiln. ANON. *Tonind.-Ztg.*, **57** [50], 582–83 (1933).—A ring kiln has been converted temporarily into a periodic kiln on account of small quantities of special products required. Construction, setting, and firing of the kiln are outlined in detail. W.M.C.

Electrical resistance furnaces for high temperatures. F. LAUSTER. *Elektrizitätswirtschaft*, Dec., 1932; abstracted in *Sprechsaal*, **66** [21], 355 (1933).—The operating

requirements for high-temperature furnaces and the importance of automatic temperature regulators for them are discussed. Metallic, nonmetallic, and liquid heating elements are differentiated. Chromite-aluminum alloys, known as "Megapyr," permit a muffle temperature up to 1250° to be reached. Some high-temperature testing furnaces suitable in the ceramic and glass industries are discussed. M.V.K.

Continuous kiln for a small output. ANON. *Brit. Clayworker*, **42** [494], 83 (1933).—A small continuous kiln of the zigzag type is described. It has been designed for a daily output of 5000 brick, with a coal consumption of less than 4 hundredweight per 1000. It is intended to replace rectangular or round downdraft kilns holding 20,000 brick and requiring a fortnight to fill, fire, and draw. An interesting feature is the placing of the flues in the upper part of the central wall, whereby an updraft is created in the drying and in some of the preheating chambers. The following advantages are claimed for the Schrele kiln: (1) leakage is much less than in the flues of ordinary continuous kilns; (2) steam and moisture is removed in a manner which admits of far less damage than when they are drawn off from the lower part of the kiln; (3) hot gases tend to rise so that a high outlet tends to improve the draft; and (4) the kiln is under better control. R.A.H.

Muffle furnaces in the ceramic industry. FRIED. BIGOT. *Rev. mat. constr. trav. pub.*, No. 285, pp. 104–108*B*; No. 286, pp. 126–34*B* (1933).—General characteristics and different types of muffle furnaces are discussed. Illustrated. M.V.K.

Chronicle of tunnel kilns. LUISE PIEPER. *Keram. Rund.*, **41** [3], 35–36 (1933).—A short historical review is given of the development of tunnel kilns. M.V.K.

Developments in gas-fired furnaces. F. J. TAYLOR. *Machinery* [London], **40**, 613–19 (1932).—The principles governing the design of town's gas and producer gas fired heating furnaces are outlined and some typical examples described and illustrated. The Wellman-Chantraine "multiflame" system of combustion, the efficiency of recuperation systems, the use of pressure burners, and the advantages of suspended roofs are thoroughly discussed. F.G.H.

Design and operation of industrial gas appliances. E. A. LEASK. *Gas Jour.*, **202** [3654], 622–25 (1933).—Cross-section diagrams and descriptions are given of the following types of furnaces: (1) natural draft, (2) recuperative oven, single control, (3) recuperative oven, reversible control, (4) gas and air blast forging furnace, and (5) metal melting furnaces. G.R.S.

Valuating draft regulators. CARL HÜTTER. *Feuerungstechnik*, **21** [5], 73–75 (1933).—Comparisons between the operation of ceramic and glassmelting furnaces with draft regulators are given. M.V.K.

Continuous regulation of kiln temperatures. RENE LEONHARDT. *Brit. Clayworker*, **42** [495], 100–107 (1933).—For the supervision of temperatures of kilns with a movable firing zone, two methods are employed. One is to fit thermoelectric pyrometers permanently in position, and the second is by means of ardometers (total radiation pyrometers) which are moved along as the firing area advances. Graphs are given and discussed which show temperatures in a properly and improperly stoked kiln. The usefulness of the CO_2 indicator and the automatic temperature regulator is also discussed in connection with regulation of kiln temperatures. R.A.H.

Building materials for the tunnel kiln. F. SINGER. *Tonind.-Ztg.*, **57** [53], 618–19 (1933).—This is a discussion of the paper by Mendheim (*Ceram. Abs.*, **12** [8], 306 (1933)). The use of a silica lining for tunnel kilns is not justified as all silica brick will be attacked by sudden temperature changes. See also *ibid.*, **12** [5], 201 (1933). W.M.C.

Protective coatings for repairing kilns. P. MÜLLER. *Tonind.-Ztg.*, **57** [52], 602–604 (1933).—Protective coatings should show a composition similar to the one of the furnace lining. Coatings should be able to withstand the highest temperatures in the kiln, thus providing a real protection of the furnace walls. Only a very small number of the coatings sold in the market will comply with these stipulations. W.M.C.

Coatings for kiln repairs. J. GREWE. *Tonind.-Ztg.*, **57** [60], 700–701 (1933).—This is a discussion of the paper by Müller (see preceding abstract). Protective coatings should be used in such cases only where they really stick to the refractory furnace walls. Coatings should not be used in firings, however. W.M.C.

Protective coatings for repairing kilns. W. SCHUEN. *Tonind.-Ztg.*, **57** [58], 676–77 (1933).—A satisfactory coating for use in stoneware kilns is a blue sintered stoneware body. This body should be ground very finely and then sprayed against the furnace walls. Spraying may also be used in repairing ring and zigzag kilns. The coating should not melt at the highest temperature of the furnace and it should contain only very small amounts of unfired materials. W.M.C.

Refractory concrete in kiln construction. ANON. *Brit. Clayworker*, **42** [495], 113–

14 (1933).—Ordinary Portland cement is useless as a binding agent for refractory concrete. The use of high alumina cements is much more satisfactory as the lime-alumina compounds produced are not so fusible as the corresponding lime-silica compounds produced with ordinary Portland cement. Rapid-hardening Portland cement is less objectionable than ordinary cement and has been used successfully for the construction of baffles. U. S. Patent 1,573,072 (*Ceram. Abs.*, **5** [4], 126 (1926)) relates to a mixture of 1 to 10 parts of calcined bauxite and 2 parts of calcium aluminate cement containing 30% of alumina. By using various kinds of grog and different proportions of cement, refractory concretes with a wide range of properties can be obtained. All such concretes have a notably weak stage at about 1750°F, but this does not interfere with their usefulness. R.A.H.

Insulating furnace crowns. A. Herberholz. *Stahl Eisen*, **53** [26], 674 (1933).—It was found that a heavy insulation of the furnace will result in the destruction of the crown in the hottest part of the furnace. The reason was that, on account of the low heat conductivity of the insulation substances, heat was accumulated inside the furnace resulting in a destruction of the furnace lining. Covering the furnace crown with a layer of granulated blast-furnace slag from 3 to 5 in. thick gave the most efficient insulation. The hottest part of the furnace was not covered. The maximum and minimum surface temperatures were decreased from 200 and 110°C, respectively, to 140 and 40°C, respectively. Advantages claimed are very low costs for the insulating material, more uniform heating of the charge, and economy of fuel. W.M.C.

Dependence upon temperature of the electric resistance of silicon carbide heating elements. L. Nawo. *Elektrowärme*, **3**, 133–35 (1933).—Investigations on commercial SiC resistors (silit, quartzite, globar) show that they have a fairly inhomogeneous structure. The ohmic resistance drops with a rise of temperature up to 700° and the more so the greater the resistivity of the element at 20°. In the temperature range above 700°, two kinds of heating elements must be distinguished: one type assumes a permanent increase in resistance at 700°, or the resistance remains almost constant; a decrease of resistance does not take place. The resistance above 700° increases the more the lower the resistivity at 20°. This was especially the case in elements with large SiC crystals. The second type increases its resistance between 700 and 1200° and decreases again from then on, or a permanent appreciable decrease of resistance takes place at 700°. It is not possible to give a generally applicable formula for calculating the resistance as SiC is not a uniform material but a mixture of crystalline and amorphous material. The change of resistance with temperature is due very likely to a growth of the SiC crystals. (*C.A.*)

Friction losses in narrow brick conduits and their meaning for heat transfer and pressure losses in recuperators. G. Schefels. *Arch. Eisenhüttenwesen*, **6**, 477–86 (1933).—Losses by friction depend on gas velocity, width of conduit, temperature, and surface conditions of the brick walls. The influence of roughness of the brick is determined by comparing results with smooth and rough surfaces. Losses are increased considerably by the presence of sharp or slightly rounded edges in the conduits. Increasing the height and decreasing the distance of edgings will increase the losses. No influence of roughness is found on the velocity and diameter factors, however. Equations permit the calculation of friction losses in the recuperators. The efficiency of heat transfer and the pressure losses are calculated. W.M.C.

Firing roofing tile. A. Gallasch. *Tonind.-Ztg.*, **57** [63], 735–36 (1933).—Difficulties encountered with roofing tile fired in a ring kiln are caused by insufficient water-smoking in the initial stages of firing. Large quantities of air should be used in water-smoking the tile. Special care should be taken to burn entirely the paper inserted in the furnace before starting the firing of the tile. W.M.C.

Furnace atmosphere for firing stoneware. Max Hauser. *Keram. Rund.*, **41** [4], 44–46 (1933); for abstract see *Ceram. Abs.*, **12** [6], 232 (1933). M.V.K.

Corrosive effect of smoke and steam in locomotives. Richard Tull. *Iron Coal Trades Rev.*, **127** [3411], 60 (1933); abstracted from *Iron Age*, **131** [24], 952 (1933).—In moisture-laden smoke from high-sulfur coal the life of cast iron that contains 11 to 14% chromium is 5 to 10 times that of ordinary gray cast iron. W.E.R.

Coal and coke investigations. H. J. Karmaus. *Emailwaren-Ind.*, **10** [18], 144–45 (1933).—The analytical determination of moisture is comparatively inexact because coal and coke may absorb or give up moisture during crushing. The best method is to weigh 2 or 3 kg. in large pieces and then dry them to constant weight at 100°. For determining ashes, 1 g. of powdered coal or coke is gently heated. Then it is heated intensively for 1 or 2 hr. to extract gas. . After complete ashing, the ashes are cooled and treated with alcohol. Unburned coal particles swim on the surface and are again calcined.

To determine the sulfur content, which is a harmful constituent of cast iron and affects the masonry of furnaces, 1 g. of finely powdered coal or coke is mixed with fired magnesia and anhydrous sodium carbonate and heated. After 1 or 2 hr., the treatment is completed. The solution is boiled out with hot water and filtered. To convert the sulfur into sulfate, several drops of bromine free from sulfuric acid are added and some hydrochloric acid to acidify. After boiling, the sulfuric acid is precipitated with barium chloride and the barium sulfate is weighed; 1 g. $BaSO_4$ corresponds to 0.1373 g. S. It is recommended to evaporate the barium sulfate to dryness to ascertain whether it is free from silica. M.V.K.

Carbonizing coal in fuel oil. ANON. *Petroleum Times*, **29** [745], 412 (1933); abstracted in *Mech. Eng.*, **55** [7], 443 (1933).—A low temperature coal-carbonization process is described in which the carbonizing is effected on a mixture of coal dust and fuel oil and is carried out in an oil still. The suspension of the fine coal in the oil is made permanent by the use of a stabilizer. The product can be pumped as readily as the fuel oil alone and is fired quite easily. F.G.H.

Coal conditioning as an aid to efficient combustion. ANON. *Fuel Econ.*, **8** [89], 303–308 (1933).—More than 3 to 5% moisture is undesirable and necessitates some form of drying if the coal is to be pulverized. Drying in the pulverizer is recommended whenever feasible. Removal of some volatile in drying is said not to be a disadvantage in the unit system but should be avoided in the storage system. On the other hand, addition of moisture up to 8 to 10%, either as water or steam, is recommended to avoid segregation of fines and resultant uneven burning on traveling grates. In cleaned coals the ash content may be so low that parts of the grate are not amply protected from heat, in which case the addition of ash up to 10% is suggested. Ash added should be neither fines nor large clinker. W.E.R.

Simple method of testing coal. G. W. HIMUS. *Sands, Clays, & Minerals*, **1** [4], 15–18 (1933).—Directions for determining moisture, volatile matter, and ash of coal are given. M.V.K.

Invisible coal consumption in brick plants. R. REH. *Tonind.-Ztg.*, **57** [51], 592–93 (1933).—The coal consumption will be reduced considerably by drying the products as well as possible. After drying, the brick and tile should be taken to the furnace immediately in order to make use of the heat remaining in the products from drying. W.M.C.

Constitution of coal. F. B. TIDESWELL. *Pottery Gaz.*, **58** [674], 975 (1933); see also *Ceram. Abs.*, **12** [9], 338 (1933). E.J.V.

Pulverized fuel and its industrial applications. G. E. K. BLYTHE. *Fuel Econ.*, **8** [93], 555–58 (1933).—Combustion and the application of pulverized fuel firing in different industries are briefly discussed. M.V.K.

Use of low-volatile duff for pulverized-fuel firing. ANON. *Steam Engineer*, **11** [5], 209–12 (1933); abstracted in *Mech. Eng.*, **55** [4], 255 (1933). F.G.H.

Adapting oil burners to pulverized-coal boilers. E. F. WALSH. *Elec. World*, **101** [16], 522–23 (1933); abstracted in *Mech. Eng.*, **55** [7], 449 (1933).—Experiments with the vertical firing of fuel oil in large pulverized coal-fired furnaces are described. Results indicate that fuel oil can be burned successfully in furnaces designed for pulverized coal and vertical firing without any changes in furnace design and with only minor changes in the burners. F.G.H.

Important properties of an oil for firing glass furnaces. Use of crude oils. W. MASKILL. *Glass Rev.*, **9** [7], 105–107 (1933). A.A.

Oil fuel in the brick industry. I. LUBBOCK. *Trans. Ceram. Soc.* [Eng.], **31**, 431–45 (1932); for abstract see *Ceram. Abs.*, **12** [1], 31 (1933). C.H.T.

Gas in the pottery industry. A. MACKAY. *Gas Jour.*, **202** [3650], 277 (1933).—Important advantages of the use of gas are as follows: (1) the weight ratio of bats and props to ware has been reduced to 1:1, compared with 10:1 when saggers are used, (2) considerably less fuel is wasted in heating up the light supporting material than in heating saggers, (3) ware is heated uniformly, accurate temperature control throughout the working space being relatively simple, (4) ware is heated more quickly, (5) goods are not discolored, and (6) by the adoption of gas firing, coupled with the use of bats and props, the two firing operations which were necessary when solid fuel was used have been carried out in one stage. See also *Ceram. Abs.*, **12** [8], 306 (1933). G.R.S.

Generator gas diagram. HANS SCHULTZE-MANITUS. *Feuerungstechnik*, **21** [5], 65–71 (1933).—Diagrams for all kinds of generator gas are developed and the relationship between separate constituents of a gas and their effect when changing their value is discussed. M.V.K.

Instruments and methods for the automatic control of producer gas. W. MASKILL. *Glass Rev.*, **9** [5], 70–72 (1933).—M. discusses the following abstract. A.A.

Automatic regulation of production and combustion of gas in a glass furnace. E. C. FISCHER. *Rev. belge ind. verrières, céram., émail.*, **3** [9], 194–97 (1932).—General principles of regulation, illustrated by diagrams, covering gas pressure, air and gas mixture, temperature control, production of gas, regulation of the mixture gas-air, and draft control are covered in a general way. P.E.C.

Composition of combustion gases and fuel gases. Relationships between their chemical contents. R. D. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 7–9 (1933). P.E.C.

Relative fuel economy of electricity, gas, oil, and solid fuel as heating agents. A. H. BARKER. *Jour. Inst. Elec. Eng.*, **72**, 269–312 (1933); see also *Ceram. Abs.*, **12** [9], 338 (1933). (*B.C.A.*)

Unburned fuel in kilns. ANON. *Brit. Clayworker*, **42** [494], 83–84 (1933).—There are several causes of incomplete combustion of fuel in continuous kilns and a number of methods of avoiding it. A common practice is to fire the kiln at longer intervals particularly near the finish of a burn. This system may reduce the quality of the ware. Shorter firing intervals with less fuel have proven successful. Unburned fuel in a chamber may be an indication that the number of preheating or cooling chambers is too small and should be increased. The fire zone may be too short, the quality of fuel may be unsuitable, or insufficient air may be passing through the kiln to cause complete combustion. R.A.H.

Fuel and firing technique. A. SANDER. *Feuerungstechnik*, **21** [4], 51–55 (1933).—A summary of reports discussed at the 12th Congress of Industrial Chemistry in Prague in 1932 deals with (1) scientific basis of coal technique, (2) preparation and drying of coal, (3) coking and swelling of coal, (4) coal gasification, (5) liquid fuel, power substances, lubricates, and (6) gaseous fuel. M.V.K.

Complete flame control attempted in highly developed firing method. F. X. QUINN. *Amer. Glass Rev.*, **52** [46], 9 (1933).—Results are given from a three-year trial in regulating flame characteristics, velocity, and carbon content. The features of control and advantages are described. C.H.T.

Scientific principles in fuel economy in the glass industry. DAVID BROWNLIE. *Glass*, **10** [8], 324 (1933).—The necessity for a consideration of the different fuels available in terms of price per available heat unit is discussed. C.H.T.

Attempted heat balance on a Manchester kiln. W. EMERY. *Trans. Ceram. Soc.* [Eng.], **31**, 361–91 (1932); for abstract see *Ceram. Abs.*, **11** [9], 499 (1932). C.H.T.

Forty years of combustion research. W. A. BONE. *Jour. Soc. Chem. Ind.*, **52** [28], 202–209*T* (1933).—A brief history of combustion research is given including discussions of (1) discoveries of "detonation" and of the influence of moisture in combustion, (2) the so-called "pressure suppression" in gaseous explosions, (3) H. B. Dixon's Manchester school, (4) theories of detonation, (5) hydrocarbon combustion, (6) surface combustion, (7) ignition phenomena and initial flame movements, and (8) gaseous combustion at high pressures. C.H.T.

Photographic analysis of explosion flames. W. A. BONE. *Gas Jour.*, **202** [3653], 515 (1933).—With the assistance of a new camera much light has been thrown upon the development and characteristics of detonation in gaseous explosions. G.R.S.

Radiation in furnaces and the new luminous diffusion combustion idea. W. MASKILL. *Glass Rev.*, **9** [4], 58–60 (1933).—In this connection the principle of diffusion combustion described by P. Q. Williams (*Ceram. Abs.*, **12** [5], 201 (1933)) is discussed. A.A.

BOOKS AND BULLETINS

Industrial Electric Heating. N. R. STANSEL. John Wiley and Sons, New York, 1933. 444 pp. Price $5.00. *Mech. Eng.*, **55** [7], 461 (1933).—The more important principles of thermal engineering are briefly reviewed. The construction of the various types of electric furnaces, their uses, and examples of their application are thoroughly discussed. See also this issue, p. 358. F.G.H.

Electrical Heat Treatment in Industry. (Die Elektrische Warmbehandlung in der Industrie.) E. F. RUSS. R. Oldenburg, Munich and Berlin, Germany, 1933. 259 pp. Cloth, 14 Rm. *Ind. Eng. Chem.*, **25** [7], 830 (1933); *Mining & Met.*, **14** [320], 354 (1933).—This volume deals with electric heating furnaces and their applications for heating, drying, enameling, tempering, annealing, etc. The fields for which electric heating is adapted are first described, after which the general construction of the electric furnace is treated. E.J.V.

Elements of Industrial Heat. Vol. I. J. A. RANDALL AND J. W. GILLON. John Wiley and Sons, New York, 1933. 261 pp. Price $2.75. Reviewed in *Mech. Eng.*, **55** [8], 522 (1933).—The fundamentals of heat engineering are presented with a minimum of mathematical discussion. The fundamental concepts, calorimetry, expansion, and changes of state caused by heat, heat transmission, fuels and combustion, air, and humidity are discussed in the first eight chapters. A final chapter is devoted to the elements of thermodynamics. F.G.H.

Fuels and Their Industrial Uses. (Die Brennstoffe und ihre Industrien.) M. DOLCH. Akademische Verlagsges., Leipzig, 1932. 200 pp. Reviewed in *Chem. & Ind.*, **52** [19], 426 (1933).—The book deals with the application of fuels to various industries. G.R.S.

Transactions on the Knowledge of Coal. (Gesammelte Abhandlungen zur Kenntnis der Kohle.) **Vol. X, 1930. Investigations of the Kaiser-Wilhelm Institute for Coal Research in Mulheim-Ruhr.** Edited by F. Fischer. G. Borntraeger, Berlin, 1932. 613 pp. Reviewed in *Chem. & Ind.*, **52** [28], 588–89 (1933).—The Transactions is divided into 6 parts containing a total of 38 papers. There are 47 illustrations, 42 graphs, and 193 tables of data. G.R.S.

International Handbook of the By-Product Coking Industry. W. GLUUD. English edition by E. M. Myers. W. Knapp, Halle (Saale) and E. Benn, London, 1932. 879 pp. Reviewed in *Chem. & Ind.*, **52** [18], 393 (1933). G.R.S.

Gas Calorimetry. C. G. HYDE AND F. E. MILLS. Introduction by C. V. Boys. E. Benn, London, 1932. 376 pp. Reviewed in *Chem. & Ind.*, **52** [18], 394 (1933). G.R.S.

Technical Data on Fuel. Edited by H. M. Spiers. Reviewed in *Mech. Eng.*, **55** [4], 270 (1933); *Mining & Met.*, **14** [320], 354 (1933); see also *Ceram. Abs.*, **12** [5], 202 (1933).

Limits of inflammability of natural gases containing high percentages of carbon dioxide and nitrogen. G. W. JONES AND R. E. KENNEDY. Bur. Mines *Rept. of Invest.*, No. 3216. 23 pp. Free. The report gives data on extinction of propane and butane flames by addition of nitrogen and carbon dioxide. Curves and tables are given which enable the limits of inflammability of natural gases containing one or more constituents of methane, ethane, propane, and butane to be calculated. R.A.H.

Comparison of methods for determining friability of coal. H. F. YANCEY AND R. E. ZANE. 24 pp. Free. Bur. Mines *Rept. of Invest.*, No. 3215. R.A.H.

Directions for sampling coal for shipment or delivery. G. S. POPE. Revised by N. H. Snyder. Bur. Mines *Tech. Paper*, No. 133. 5¢ from Supt. of Documents, Govt. Printing Office, Washington, D. C. R.A.H.

PATENTS

Kiln. H. M. ROBERTSON. U. S. 1,919,258, July 25, 1933. J. T. UNDERWOOD. U. S. 1,921,553, Aug. 8, 1933. A kiln comprises a ware firing chamber, a combustion chamber located at the center of and below the floor of the firing chamber, means for delivering gaseous fuel to the combustion chamber, a flue extending upwardly from the combustion chamber into the firing chamber, stacks located outside the firing chamber, and a circumferentially extending draft tunnel disposed within the outer wall and below the floor of the ware firing chamber adjacent the outer margin thereof.

Method of and apparatus for glazing ceramic ware. CONRAD DRESSLER (Swindell-Dressler Corp.). U. S. 1,919,322, July 25, 1933.

Fuel vaporizer and method of making. W. C. LINDEMANN AND A. T. SCHMIDT (A. J. Lindemann & Hoverson Co.). U. S. 1,923,546, Aug. 22, 1933.

Tunnel kiln. W. A. HULL. U. S. 1,923,729, Aug. 22, 1933. GIBBONS BROS., LTD., AND W. E. GIBBONS. Brit. 395,983, Aug. 2, 1933.

Recuperative counter-flow furnace. E. L. SMALLEY (Hevi-Duty Electric Co.). U. S. 1,924,167, Aug. 29, 1933.

Firing of ceramic ware. J. T. BAMFORD. Brit. 397,339, Aug. 30, 1933.

Muffle furnaces. GIBBONS BROS., LTD., AND THOMAS E. BRIDGFORD. Fr. 742,991, March 21, 1933. (*C.A.*)

Electric furnaces. PAUL L. J. MIGUET AND MARCEL P. PERRON. Fr. 743,195, March 25, 1933. The construction of a conducting envelope and heat insulator for the furnace hearths is described. (*C.A.*)

Annular kiln for ceramic ware. OTTO BUSCH. Ger. 574,058, April 8, 1933. (*C.A.*)

Furnace for firing porcelain, etc. ARTHUR S. WATTS. Ger. 575,307, April 27, 1933. (*C.A.*)

Geology

Hydrogen-ion concentrations caused by the solution of silicate minerals. R. E. STEVENS. *Jour. Wash. Acad. Sci.*, **22**, 540 (1932).—By grinding silicates under water, solutions with characteristic and reproducible p_H values are obtained. Silicate minerals, when acted on by pure water, give highly alkaline solutions which are important regulators of geochemical changes. The p_H value obtained is a rough index of the weathering qualities of the mineral. J.B.A.

Photography for the mineralogist. M. M. STEPHENS. *Amer. Mineralogist*, **18** [6], 248–59 (1933).—A discussion is given of (1) color as recorded by the eye, (2) light filters, (3) sensitive emulsions, (4) use of filters, (5) cameras for the mineralogist, (6) exposure of the emulsions, (7) artificial light, (8) special hints, and (9) processing the negatives and prints. G.R.S.

Laue reflection photographs on vibrating quartz rods. E. BLECHSCHMIDT AND W. BOAS. *Z. Krist.*, **85** [3–4], 329 (1933).—Experiments were conducted on rods cut in different directions from quartz rods. G.R.S.

Behavior of mineral zeolites toward liquid ammonia. ERHARD GRUNER. *Z. anorg. allgem. Chem.*, **211** [4], 385–97 (1933).—A contribution on the structure of the zeolites is presented. By means of the Biltz ammonia extraction process some of the natural zeolites were dehydrated. A part of the water of the zeolites is bound as $(Ca(H_2O)_2)^{\cdot\cdot}$ and can be removed by liquid ammonia. Some of the rest of the water behaves as if it were combined as a hydrate of silica. The remainder can not be replaced by liquid ammonia and is therefore part of a "zeolite nucleus." L.T.B.

Chemical studies of silicates. I and II. ERICH THILO. *Z. anorg. allgem. Chem.*, **212** [4], 369–84 (1933).—Studies on the behavior of silicates with certain chemicals were made in order to determine if a close relation exists between the crystal structure and chemical properties of the silicates. In the experiments pyrophyllite was heated with the following chlorides and oxides: $MgCl_2$, MgO, $CoCl_2$, $NiCl_2$, $FeCl_3$, CuO, ZnO, CdO, and CaO. Between 700 and 1000°C the two atoms of hydrogen in pyrophyllite can be replaced by Mg, Co, and apparently Ni and Fe. This behavior is interpreted on the basis of Pauling's crystal structure theories. L.T.B.

Fibrous structure and optical properties of chalcedony. C. W. CORRENS AND G. NAGELSCHMIDT. *Z. Krist.*, **85** [3–4], 199–213 (1933).—The X-ray study of chalcedony from different sources showed that it consisted of quartz which had grown as fibers in two directions. One direction $[11\bar{2}0]$ is at right angles to the prism, the other $[1\bar{1}00]$ is at right angles to the edge of the prism. Both chalcedonies which exhibited these types best were examined optically. Their optical properties could be determined with fairly good agreement under the hypothesis that the fibers, in addition to exhibiting negative double refraction in their long direction as individuals, showed a positive double refraction as a whole. G.R.S.

Crystal structure and a comparison of certain optical properties of the kaolin group with its structures. J. W. GRUNER. *Z. Krist.*, **85** [5–6], 345–54 (1933).—The structure of nacrite from Brand, Saxony, was examined by the powder method. The nacrite seemed to be slightly contaminated with dickite. Nacrite from St. Peters Dome, Colo., contains considerable amounts of admixed dickite. The dimensions of the monoclinic hemihedral unit cell are $a_0 = 5.16$Å, $b_0 = 8.93$Å, $c_0 = 28.66$Å, and $\beta = 91°43'$. The axial ratio is 0.578 : 1.000 : 3.209. The cell contains 8 molecules $(OH)_8Al_2Si_2O_5$. The theoretical density is 2.581. The space group is C_s^4. Nacrite is built of the same kind of layers or sheets as dickite and kaolinite but differs in one important respect, *i.e.*, each layer is rotated 180° in its own plane with respect to its nearest neighbors. The inclinations of the optic axial planes in the three minerals seem to be proportional to the shifts of the layers in the direction of the *a* axis. The shift in the *b* axis seems to determine the optic sign and $2V$ on the mineral. G.R.S.

The question of kaolin formation. E. DITTLER. *Z. anorg. allgem. Chem.*, **211** [1–2], 33–40 (1933).—D. attempted to synthesize kaolin by bringing about a reaction between pure alumina and silica sols. He concluded that the formation of kaolin is not a simple flocculation reaction between alumina and silica sols but a true chemical reaction in which the ions are involved. See also *Ceram. Abs.*, **12** [2], 76 (1933). L.T.B.

Structure of sanidine and other feldspars. W. H. TAYLOR. *Z. Krist.*, **85** [5–6], 425–42 (1933).—An attempt was made to determine the structure of sanidine using data obtained from rotation photographs. A monoclinic structure based on a framework of linked (SiO_2) and (AlO_4) tetrahedra is suggested and its principal features are described. G.R.S.

Correction and completion of the diagram for the estimation of feldspars according

to Fedorov's method. W. W. NIKITIN. *Mineralog. petrog. Mitt.*, **44** [2-3], 117-67 (1933).—An intensive study was made of albite, nine samples from widely separated localities being investigated. Important topics in the report are (1) chemical composition and its relationship to the optical properties of albite, (2) diagram of the most important geometrical elements of feldspar in relation to the symmetry axes of the optical indicatrix, (3) real lime feldspar, (4) diagrams of extinction angles and double refraction, and (5) cleavage slope of plagioclases. G.R.S.

Cobalt and its uses. L. SANDERSON. *Sands, Clays, & Minerals*, **1** [4], 51-57 (1933).—The metal cobalt was first prepared in the 18th Century; glass of the blue color due to the presence of cobalt has been known from the earliest times, examples of it having been found in ancient Egyptian tombs and in the ruins of Troy. Cobalt is never found in the pure state. The six main minerals from which it can be extracted are (1) smaltite ($CoAs_2$), (2) cobaltite (CoS_2CoAs_2), (3) linnæite or cobalt pyrites ($CoSCoS_2$), (4) glaucodot ((CoFe)AsS), (5) erythrite ($Co_3As_2O_8H_2$), and (6) asbolite or cobaltiferous wad (composition uncertain); there are also a number of far less important cobalt ores. The principal use of compounds of cobalt is as pigment. In the enamel, glass, and pottery industries compounds of cobalt are practically the only blue coloring matters used. The famous blue glass (bleu de Saxe) is a silicate of potash and cobalt. M.V.K.

Use of bentonite. ANON. *Refrac. Jour.*, **9** [5], 198 (1933).—The characteristics and colloidal properties of bentonite are briefly described. C.H.T.

Fluorspar. A. WILSON. *Sands, Clays, & Minerals*, **1** [4], 6-11 (1933).—Data on the output, deposits, uses, and characteristics of fluorspar are given. It is seldom found in the pure state and may contain galena, zinc blende, silica, baryta, or calcite. Fluorspar used in the manufacture of enamelware and glassware should not contain more than 2 or 2.5% silica, up to 1% $CaCO_3$, and no measurable quantity of iron, lead, or zinc. The optical spar occurs in few mines. It must be clear and perfectly colorless to be used for lenses and prisms. M.V.K.

Genesis of gangue. J. E. METCALFE. *Sands, Clays, & Minerals*, **1** [4], 33-39 (1933).—M. deals with (1) the gangue minerals, quartz, calcite, fluorspar, barite, witherite, siderite, and iron pyrites, (2) the occurrence of metals, (3) ore genesis, (4) economies of gangue minerals, and (5) dressing of minerals. M.V.K.

Greenstone-like andesite facies, their causes and relation to kaolinization and silicification. G. H. BURG. *Z. prakt. Geol.*, **39**, 187-92 (1931).—A systematic study is presented of the transformations taking place on the cooling of andesite and pyroxene-amphibole-andesite magmas. Propylitization is an autometamorphosis occurring during cooling of the magma including chloritic and zeolitic propylitization, while kaolinization is a hydrothermal process. The latter is accompanied by sericitization and carbonization. Silicification takes place at the end of the gangue formation and influences the secondary rock below the cementation zone. A chart illustrating the progressive changes taking place during magma solidification is given. R.H.E.

Origin of the sand barites of the lower Permian of Oklahoma. W. A. TARR. *Amer. Mineralogist*, **18** [6], 260-72 (1933).—Barite concretions and barite crystal aggregates, known as "sand barites" or "barite rosettes," occur in sandstones in the Garber formation in central Okla. The barite in both types cements the sand grains together. It is believed that the barium was derived from barium silicates (such as barium feldspars), barium adsorbed in colloids, or detrital grains of barite. It was leached out by chloride waters forming $BaCl_2$, carried a variable distance, and deposited as a cementing material in the sandstone through reaction with some soluble sulfate to form the extremely insoluble $BaSO_4$, which assumed the form of the rounded concretions or the crystal aggregates. G.R.S.

Corvusite and rilandite, new minerals from the Utah-Colorado carnotite region. E. P. HENDERSON AND F. L. HESS. *Amer. Mineralogist*, **18** [5], 195-205 (1933).—These minerals are found in the sandstone and accompanying clays of the carnotite-bearing deposits of Colo. and Utah. Descriptions and chemical analyses of the minerals are given. Some of the X-ray lines of rilandite correspond closely with those of the beidellite type of clay, although several strong lines are different. G.R.S.

Volume, shape, and roundness of rock particles. H. WADELL. *Jour. Geol.*, **40** [5], 443-51 (1932).—This paper deals with the fundamental principles, conceptions, and ideas upon which some new sedimentological research methods are based. See following abstracts. G.R.S.

Shapes of rock particles: a discussion. C. K. WENTWORTH. *Jour. Geol.*, **41** [3] 306-309 (1933).—W. discusses the preceding abstract. G.R.S.

Sphericity and roundness of rock particles. H. WADELL. *Jour. Geol.*, **41** [3],

310–31 (1933).—In answer to C. K. Wentworth's criticisms, W. discusses (1) Wentworth's shape determinations, (2) degree of sphericity of a particle, (3) roundness, (4) practical method of determining the sphericity value of quartz particles, (5) modification of shape and roundness of rock particles by nonchemical forces, and (6) modification of shape and roundness of rock particles by solution. G.R.S.

Studies of refractory minerals. ANON. *Refrac. Jour.*, **9** [5], 198 (1933).—The properties of English china clay are described and the analysis of four typical refractory clays is listed. C.H.T.

Clays of southeast England. H. G. DINES. *Trans. Ceram. Soc.* [Eng.], **32** [2], 64–90 (1933); for abstract see *Ceram. Abs.*, **12** [3], 126 (1933). C.H.T.

English china clay. A. R. DAVIES. *Sands, Clays, & Minerals*, **1** [4], 58–61 (1933).—The history, formation, and physical and chemical properties of china clay are discussed. M.V.K.

Clay. V. C. *Rev. mat. constr. trav. pub.*, No. 286, pp. 121–23*B* (1933).—The general properties of clay, its genesis, and deposits found in France are described. M.V.K.

West Bohemian kaolin and clay deposits. W. R. ZARTNER. *Zprávy Československ. keram. společnosti*, **9** [1–2], 61–75 (1932); abstracted in *Feuerfest*, **9** [6], 92 (1933).—The origin of kaolins and clays, geological stratification, origin, and composition of Zettlitz and Kaaden kaolins, and the clay deposits of Eger-Wildstein basin are discussed. M.V.K.

Plagioclase in the trachydolerite of Pauliberges (Bergenland). H. WISENEDER. *Mineralog. petrog. Mitt.*, **44** [2–3], 199–204 (1933).—The study of the plagioclase in the basic eruptive rocks of Pauliberges showed that they had a regular and abundant occurrence of twins with (001) as the twinning plane. The regularity of twinning apparently depends upon the alkali content of the rocks. G.R.S.

Beryl occurrence at Tergova, Rumania. E. DITTLER AND F. KIRNBAUER. *Z. prakt. Geol.*, **39**, 49–56 (1931).—Beryl occurs in pegmatite with quartz, feldspar, muscovite, tourmaline, garnet, apatite, biotite, pyrite, magnetite, and columbite. Its analysis is as follows: SiO_2 64.5%, Al_2O_3 18.75, BeO 12.60, Fe_2O_3 0.81, CaO 0.48, MgO 1.03, K_2O 0.49, Na_2O 1.41. R.H.E.

Clays of the Gubinskii deposits and their utilization in the ceramic industry. S. G. TUMANOV. *Keram. i Steklo*, **9** [4], 15–19 (1933).—Two main types of clays are found, (1) fat clays, and (2) lean sandy clays containing from 20 to 50% sand. The former contain from 0.2 to 3% sand and a high content of alkalis. Their refractoriness ranges between 1500 and 1530°. Attempts to use them in saggers, majolica for electrotechnical porcelain, and acid stable ware gave satisfactory results. M.V.K.

Utilization of Ukrainian kieselguhr in the cement and refractory industries. P. P. BUDNIKOFF AND V. V. BELOVODSKIĬ. *Ukrain. Khem. Zhur.*, **7** [3], 103–12 (1932).—A detailed account of researches made to use kieselguhr in the refractory and cement industries is given. The results are tabulated. Insulating brick with 50% porosity have been produced which may be used for temperatures not exceeding 750°. M.V.K.

Refractory clays from the Kurinskii deposits. N. KARZHAVIN. *Trans. State Ceram. Research Inst.* [Moscow], No. 35, pp. 1–13 (1932).—A geological description and the genesis of the Kurinskiĭ deposits of refractory clays in the Urals are given. M.V.K.

BOOKS AND BULLETINS

French-English Vocabulary in Geology and Physical Geography. G. N. DAVIES. ix + 140 pp. Thomas Murby and Co., London; D. Van Nostrand Co., New York, 1932. 6s net. Reviewed in *Nature*, **131** [3313], 604 (1933).—Between four and five thousand words are included. A comparative table of English and Continental stratigraphical terms is included in an appendix. J.L.G.

Crystallometric Determinative Methods. (Krystallometrische Determineerings-Methoden.) JAN H. HAAN. J. B. Wolters, Groningen, 1932. 178 pp. Reviewed in *Amer. Mineralogist*, **18** [7], 310 (1933).—H. has tabulated and classified the geometric constants of 950 chemical compounds according to the method proposed by Barker. In 45 pages of text he discusses the proposals that have been made for the erection of systems of classification of the geometric properties of crystals to be used for the purpose of identifying an unknown compound. G.R.S.

Descriptive Petrography of the Igneous Rocks. Vol. II. Quartz-Bearing Rocks. ALBERT JOHANNSEN. University of Chicago Press, Chicago, 1932. Price $5.50. Reviewed in *Amer. Mineralogist*, **18** [7], 311 (1933).—This work describes the quartz-bearing rocks from silexite to quartz-calciclase-gabbro. The descriptions are excellent,

brief but adequate, and they are usually preceded by an interesting discussion of the historical development of the name and numerous references to the literature. The quantitative mineral composition and the chemical analysis are given of all the rocks for which the former data are available. When completed, Johannsen's four volumes should be the world's standard on the subject of descriptive petrography. For Vol. I see *Ceram. Abs.*, **11** [11], 593 (1932). G.R.S.

Tables for the Calculation of Mineral and Rock Analyses. (Tabellen zur Berechnung von Mineral- und Gesteins-Analysen.) H. VON PHILIPSBORN. Akademische Verlagsgesellschaft, Leipzig, 1933. Foreword in German and English. 310 tables. Reviewed in *Z. Krist.*, **85** [3–4], 333 (1933).—This useful book contains a table of molecular equivalents and weight per cent of all the heavier oxides and many more for mineral salts of the heavier metals. It contains tables for the calculation of molecular equivalents from weight per cent and *vice versa*. Tables are also given dealing with specific gravity and volume of minerals. The theoretical composition of minerals and mixed crystals is treated. All calculations are based on the international atomic weights of 1932. G.R.S.

Mineral Industries of the British Empire and Foreign Countries: Lithium. IMPERIAL INSTITUTE. H. M. Stationery Office, London, 1932. 27 pp. Reviewed in *Chem. & Ind.*, **52** [18], 387 (1933); see also *Ceram. Abs.*, **12** [2], 79; [5], 203 (1933). G.R.S.

Manganese. R. H. RIDGWAY. Bur. Mines *Information Circ.*, No. 6729. 31 pp. Free. This circular outlines salient facts regarding the manganese-ore industry in the U. S. and the world. The properties of manganese, mode of occurrence, sources, production, uses, prices, exports, and imports are discussed. A fairly complete bibliography is attached. R.A.H.

Identification of cerussite and anglesite, and flotation with galena. F. D. DEVANEY AND R. E. EVANS. Bur. Mines *Rept. of Invest.*, No. 3214. 9 pp. Free. The report describes the ore used in the study and gives results of concentration, gravity concentration, and flotation tests. R.A.H.

Abstracts of current articles on geophysical prospecting. F. W. LEE. Bur. Mines *Rept.*, GA 50, 27 pp.; GA 51, 25 pp. For No. 49 see *Ceram. Abs.*, **12** [9], 341 (1933). R.A.H.

Refractory clays of Kuzovlevo. A. FEDOSEEV. *Trans. State Ceram. Research Inst.* [Moscow], No. 38, 20 pp. (1932).—A general description of the clay deposits is given. The clays have a high silica content, 62 to 69%, 20 to 25% alumina, 1.1% iron oxide, and 1.8% alkalis. Their ceramic properties and applications in industry are discussed in detail. M.V.K.

Chief properties of clays from Latninskii deposits. K. KELER. *Trans. State Ceram. Research Inst.* [Moscow], No. 37, 55 pp. (1932).—A detailed account is given of investigations made on refractory clays of the Latninskii deposits including (1) chemical and mechanical composition, (2) water content, (3) bonding capacity, (4) shrinkage on drying and firing, (5) porosity at different temperatures of firing, (6) refractoriness, (7) temperature interval between sintering and melting, and (8) macroscopic description. A rational classification of the clays is also given. See also article by Zubchaninov, *Ceram. Abs.*, **12** [1], 34 (1933). M.V.K.

Chemistry and Physics

A compilation of phase-rule diagrams of interest to the ceramist and silicate technologist. F. P. HALL AND HERBERT INSLEY. *Jour. Amer. Ceram. Soc.*, **16** [10], 455–568 (1933).

Phase diagram of two- and three-component systems in ceramics. PAUL BECK. *Sprechsaal*, **66** [16], 265–67; [17], 283–85 (1933).—The parts of the phase diagram are described as they result from the phase theory for "condensed" (containing only liquid and solid phases) two- and three-component systems found in equilibrium. The application of the diagram for describing melting and solidification processes and deviations from the state of equilibrium in practical operating conditions is discussed. M.V.K.

Estimation of latent heats of vaporization. J. H. ARNOLD. *Ind. Eng. Chem.*, **25** [6], 659–61 (1933).—The empirical rule of Hildebrand, as expressed by Lewis and Weber and improved by McAdams and Morrell, is shown to be an incomplete form of an accurate empirical equation due to Dieterici and tested by Mills. Graphical representation of the available calorimetric data indicates that the Dieterici equation is reliable to 5% or better over the range from room temperature to the critical point. F.G.H.

Migration studies with colloids. I. Effect of electrolytes and of colloids of opposite sign on the stability of colloidal systems. F. HAZEL AND D. M. MCQUEEN. *Jour. Phys. Chem.*, **37** [5], 553–70 (1933).—An ultramicroscopic method was used to follow the changes in stability of sol-electrolyte mixtures and of mixtures of oppositely charged colloids with changes in concentration. Lyotropic series for the coagulating ions were determined for each colloid system, and the results were critically examined. **II. Mechanism of the mutual coagulation process.** *Ibid.*, **37** [5], 571–82 (1933).—Data were presented to show the influence of electrolytes upon the migration velocities of mixtures of positive and negative colloids. Mutual coagulation is due to a lowering in the stability of the system caused by mutual adsorption of the two colloids with a consequent unequal redistribution of the total charges around the aggregates. G.R.S.

Diffusion and electrolytic conduction in crystals. Ionic semiconductors. W. JOST. *Jour. Chem. Phys.*, **1** [7], 466–75 (1933).—A mechanism of diffusion and electrolytic conduction in solids is discussed. G.R.S.

Solution and colloidal dispersion of minerals in water. P. G. NUTTING. *Jour. Wash. Acad. Sci.*, **22**, 261 (1932).—Saturated solutions of many ordinary clays and decomposed rocks in pure water after repeated washing range in concentration from 30 to 100 parts per million. Saturation is approached in 10 hr. at 80°C and in 400 hr. at 25°C. True rock solutions free from particles in suspension may be concentrated to several thousand parts per million without precipitation. Organic matter is commonly associated with silica as soluble silicates which may be transported and decomposed elsewhere. Many decomposed igneous rocks may be converted into bleaching clays by the action of water alone but the high quality of the best bleaching clays depends to some extent on the composition of the original rock. Many bleaching clays can be converted to plastic ball clays by the action of water alone. J.B.A.

Physical chemistry of flotation. I. Significance of contact angle in flotation. I. W. WARK. *Jour. Phys. Chem.*, **37** [5], 623–44 (1933).—The following topics are treated: (1) equation to the surface of a stationary bubble of air in water, (2) arithmetical solution of the equation for bubbles of different sizes, (3) equation connecting volume of bubble, angle of contact, and area of air-solid contact, (4) solution of equation III, (5) replacement of solid-water contact by solid-air contact, tenacity of adhesion, (6) true and apparent area of contact, (7) difficulties in experimental determinations of angle of contact-hysteresis and its physical nature, (8) stability of air-mineral attachments, extension to moving systems, (9) froths and air-mineral aggregates, and (10) maximum size of particle which will float. **II. Nature of the adsorption of the soluble collectors.** A. B. COX AND I. W. WARK. *Ibid.*, **37** [6], 797–803 (1933).—Two topics discussed are (*a*) the conditions under which adsorption of the collector occurs and (*b*) the rate at which adsorption occurs. **III. Relationship between contact angle and the constitution of the collector.** ELSIE E. WARK AND I. W. WARK. *Ibid.*, **37** [6], 805–14 (1933).—When contact occurs, the angle at the line of triple contact air-solid-solution is dependent only upon the nonpolar group of the adsorbed collector. It is independent of the nature of the solid, of the polar or anchoring group of the collector, and of the concentration of the collector. Whether adsorption of the collector occurs at a mineral or metal surface depends on the solubility of the corresponding metal salt of the collector. **IV. Criticism of Ostwald's theory of flotation.** I. W. WARK AND A. B. COX. *Ibid.*, **37** [6], 815–19 (1933). G.R.S.

Universal direct-reading hydrogen-ion potentiometer. C. MORTON AND F. L. BEST. *Jour. Soc. Chem. Ind.*, **52** [2], 6–8 (1933).—In routine p_H determinations much time and labor may be saved by using an instrument calibrated directly in p_H units. In the instrument devised by the authors a single scale, by means of which readings may be obtained either in millivolts or in p_H units, is provided. The ranges are 0 to 1400 mv. and 0 to 14 p_H units, respectively, readings being obtained directly to 1 mv. or 0.01 p_H unit. A general description and diagram of the electrical circuit are given. G.R.S.

New method for the determination of the moduli of elasticity. P. LEROLLAND AND P. SORIN. *Compt. rend.*, **196**, 536–38 (1933).—The precise measurement of moduli of elasticity requires that the following conditions be satisfied: (1) deformations must be perfectly elastic and hence very small, (2) deformations should be alternating to obtain elastic accommodation, and (3) the cycle of deformation should be a definite known function of time. These conditions are satisfied in the procedure described. The test piece is a right prism of rectangular cross-section mounted vertically with its lower end rigidly fixed. A horizontal plate is rigidly mounted at the upper extremity of the test piece and from it two identical pendulums are suspended on knife edges. One pendulum is started swinging with the other at rest and the time between complete

stoppages of a single pendulum is measured. From this time and the dimensions of the test piece Young's modulus may be computed. A series of determinations will have a spread of 1 to 2%. For a very rigid test specimen, horizontal or vertical elastic pendulums may be used instead of gravity pendulums in order to add a couple to the force acting on the rod. To obtain Coulomb's modulus, two identical torsion pendulums are used mounted from a vertical rod fixed at its upper extremity. It is to be noted that neither stress nor deformation need be directly measured, and the precision of the time measurement may be made as great as desired by using a sufficient number of beats. (*Rev. Sci. Inst.*)

X-ray examinations of ceramic raw materials. I and II. T. NAKAI AND Y. FUKAMI. *Jour. Soc. Chem. Ind.* [Japan], **36** [6], 349–51*B*; [7], 434–35*B* (1933).—The inner crystalline structure of feldspar, silica, and 6 kinds of clays, kaolins, and alumina was studied when raw and after firing. It was found that kaolin begins to lose its crystalline structure between 350 and 400°C and loses it completely at 780°C. Kaolin decomposes into amorphous alumina and silica, giving off the water of crystallization. However, the amorphous alumina changes its form to crystalline at 900°. When a great deal of quartz is present in the clay, the change in the crystalline structure of kaolin is difficult to observe. Coarse grains of quartz hinder the change of amorphous alumina into the crystalline state. Chemically prepared alumina changes its structure more than 3 times when subjected to heat treatment. At 1500°C, its crystalline form is similar to that of corundum. The results obtained by X-ray analysis coincide well with those obtained by chemical methods. M.V.K.

X-ray analysis of Seger cones. TOSHIO NAKAI AND YOSHIO FUKAMI. *Jour. Soc. Chem. Ind.* [Japan], **36** [4], 170–71*B* (1933).—The reaction between the components of the cones during heating was studied. M.V.K.

International comparison of temperature scales between 660 and 1063°C. WM. F. ROESER, F. H. SCHOFIELD, AND H. A. MOSER. Bur. Stand. *Jour. Research*, **11** [1], 1–5 (1933); R.P. 573.—This paper reports an intercomparison of the temperature scales (in the range 660 to 1063°C) in use at the National Physical Laboratory, the Physikalisch-Technische Reichsanstalt, and the Bureau of Standards since 1927. It is shown that the methods used in realizing the International Temperature Scale have yielded results differing by as much as 0.7°C at 850°C due primarily to a difference of 0.4°C at the freezing point of silver, one of the basic fixed points of the International Temperature Scale. After exchanging samples of silver and thermocouples the various scales have been brought into agreement within 0.1°C at all points in the range covered. R.A.H.

Present status of the standards of thermal radiation maintained by the Bureau of Standards. W. W. COBLENTZ AND R. STAIR. Bur. Stand. *Jour. Research*, **11** [1], 79–87 (1933); R.P. 578.—The present status of the value of the constant of total radiation is reviewed and it is concluded that, for the present, the basis of the lamp calibration remains unchanged. R.A.H.

Measurement of metal temperatures on the heat-receiving side of heat-exchanging apparatus. A. WILLIAMS. *Mech. Eng.*, **55** [5], 321–22 (1933); for abstract see *Ceram. Abs.*, **12** [8], 301 (1933). F.G.H.

Control through spectroscopy. E. S. DREBLOW AND A. HARVEY. *Ind. Eng. Chem.*, **25** [7], 823–25 (1933). F.G.H.

Mineralogy as help in ceramics. D. S. BELIANKIN. *Keram. i Steklo*, **9** [4], 23–26 (1933).—B. discusses the importance of mineralogy and microscopical analyses in the study of ceramic materials. M.V.K.

Pressure regulator for gas filled X-ray tubes. F. D. MILES. *Trans. Faraday Soc.*, **29** [7], 788–89 (1933).—A diagram of the tube is shown and its operation is explained. G.R.S.

Adhesion tension. Pressure of displacement methods. F. E. BARTELL AND H. J. OSTERHOF. *Jour. Phys. Chem.*, **37** [5], 543–52 (1933).—An account is given of the preliminary work carried out in the development of methods for the determination of adhesion-tension data. The pressure of displacement methods for the measurement of adhesion tension is described in detail. Adhesion-tension values and work of adhesion values obtained with a series of liquids against silica and carbon are given. G.R.S.

Fundamental frequencies of the group SiO_4 in quartz crystals. J. WEILER. *Nature*, **130** [3293], 893 (1932).—The particular properties of quartz crystals (SiO_2) as compared with those of carbon dioxide (CO_2) have lead William Bragg to consider a quartz crystal as a single molecule. An analogous constitution is shown by the polymeric homologue series of silica esters whose Raman spectra W. has recently investigated. In these compounds four characteristic scattered frequencies must be attributed to the group

SiO_4. Two of these frequencies are independent of the degree of polymerization while the two others show a continuous shift with the degree of polymerization. The line 642 cm.$^{-1}$ of the monomeric ester is shifted as far as 518 cm.$^{-1}$ which corresponds to a line of the decameric ester. By utilizing the Raman spectra results the fundamental frequencies of the SiO_4 group in quartz can be located. These are shown in the following table:

	ν_1	ν_2	ν_3	ν_4
νcm.$^{-1}$	502	800	1062–1086	1170–1208
$\lambda\mu$	19.92	12.5	9.4_1–9.2_1	8.54–8.28

By using these four fundamental frequencies the entire ultra-red spectrum of quartz below 10μ can be interpreted as a system of combination bands of the second to fourth order. J.L.G.

Plasticity of quartz. K. ZINSERLING AND A. V. SHUBNIKOV. *Z. Krist.*, **85** [5–6], 454–61 (1933).—A short historical review of the question of the plastic deformation of quartz is given. Symmetrical mechanical twins on different crystal surfaces of quartz were studied. Twinning figures on any optional surface can be theoretically derived from the space model of the twin. The stretching limit of quartz at about 573°C becomes approximately fixed; its value is about 15 times as small as at room temperature. Three kinds of plasticity were distinguished. G.R.S.

Crystal structure of sillimanite and related materials. W. H. TAYLOR. *Trans. Ceram. Soc.* [Eng.], **32** [1], 7–13 (1933); see also *Ceram. Abs.*, **11** [12], 619 (1932). C.H.T.

Four crystalline hydrates of sodium metasilicate. C. L. BAKER, H. T. WOODWARD, AND A. PABST. *Amer. Mineralogist*, **18** [5], 206–15 (1933).—Four definite hydrates of sodium metasilicate were prepared and their physical and crystallographic properties were determined. A complete phase equilibrium study of the system, Na_2O–SiO_2–H_2O, is under way, and the results will be published at a later date. G.R.S.

Correct setting of crystals. G. GREENWOOD. *Z. Krist.*, **85** [5–6], 420–24 (1933).—The choosing of the axes of reference for crystals is discussed. G.R.S.

Crystal structure of tenorite (cupric oxide). G. TUNELL, E. POSNJAK, AND C. J. KSANDA. *Jour. Wash. Acad. Sci.*, **23** [4], 195–98 (1933).—Tenorite has monoclinic symmetry, the dimensions of the unit cell in Å being $a_0 = 4.66$, $b_0 = 3.40$, $c_0 = 5.09$, all ± 0.02. $\beta = 99°30' \pm 30'$. The space group appears to be $C_2/c(C^6_{2h})$. The Cu atoms occupy centers of symmetry and the O atoms are situated on planes of symmetry. The distance Cu–O is 1.9 + Å. J.B.A.

Crystals of iron-rich pyroxene from a slag. N. L. BOWEN. *Jour. Wash. Acad. Sci.*, **23** [2], 83–87 (1933).—A high-iron pyroxene has been found in a slag from a copper reverberatory furnace. Its composition appears to be $FeSiO_3$ 69.3, $CaSiO_3$ 6.7, $MgSiO_3$ 8.2, Al_2O_3 4.8, Fe_3O_4 5.2, and ZnS 3.4. It is monoclinic with $a:b:c = 1.0786:1:0.5828$ and $\beta = 71°31'$. The plane of the optic axes is parallel to 010 and the extension angle $(c\Lambda\gamma) = +36°$. The refractive indices are $\gamma = 1.785$, $\alpha = 1.745 \pm 0.003$. The optic axial angle is small, $+2V = 20$ to 25°. Prismatic cleavage is perfect. J.B.A.

Rapid and accurate analysis of bituminous materials. D. M. WILSON. *Chem. & Ind.*, **52** [28], 578–81 (1933).—A modified method for analyzing bituminous materials where great speed is required is recommended and described. Illustrated. C.H.T.

Volatility of silica with steam. GEORGE W. MOREY. *Trans. Amer. Geophys. Union 13th Ann. Meeting*, pp. 269–70 (1932).—Attempts to repeat the experiments of Van Nieuwenburg and H. B. Blumendal (*Ceram. Abs.*, **10** [2], 152; [10], 735 (1931)) led to entirely different results. Transport through the vapor phase, if any, was infinitesimal. In the original experiments expansion of the liquid water may have caused immersion of the crucibles and transport through the liquid instead of vapor phase. (*C.A.*)

Simplification of the alkali determination in silicates according to the Lawrence Smith method. W. PUKALL. *Sprechsaal*, **66** [14], 231–32 (1933).—The simplification of the Smith method for determining alkalis in silicates may be reached as follows: (1) by the replacement of the decomposing agent heretofore utilized by a similar but more advantageous agent resulting in a considerable lowering of the amount by weight, (2) through a simplification and cheapening of the decomposition vessel, and (3) through a simplification and shortening of the procedure. The advantages accruing from this are a guaranty of general use, considerable economy in time, simplicity in analyzing, and at least an identical accuracy in results if not higher. M.V.K.

Combination of water in the kaolin molecule. Replacement of water by alkali for measuring the quantity of kaolin present. H. HIRSCH AND W. DAWIHL. *Keram. Rund.*, **41** [14], 172–74 (1933).—Of the 2 molecules of water in the kaolin molecule, $1^1/_2$ molecules are expelled in a saltpeter melt at 500°, while only $^1/_2$ molecule is replaced by potassium oxide. When heated to 500°, metakaolin reacts almost in the same manner, the hydrate of silica and alumina react differently, and mica does not show any interchange. This is proof that a part of the water present in the metakaolin molecule, *e.g.*, $^1/_2$ molecule, is combined in a special way and that after its expulsion at 500° the alumina and silica are still combined in a certain chemical way in metakaolin. The saltpeter-melt reaction can be employed for determining the kaolin substance content of a mixture, and hence it can be used for a rational analysis, whereby the determination of the acid-soluble potassium oxide is used as a measure for the quantity of kaolin present. M.V.K.

Simplified method for testing the plasticity of clays and kaolins by the determination of the "plasticity numbers." P. N. SHABLUIKIN AND E. A. GALABUTSKAYA. *Mineral. Suir'e*, **7** [11–12], 32–37 (1932). (*C.A.*)

Studies of the thermal and chemical changes of Kato-kaolin. TAKEO AO. *Jour. Soc. Chem. Ind.* [Japan], **36** [1], 12–13*B* (1933).—When heated to 600°, the Kato-kaolin decomposes into free Al_2O_3, free SiO_2, and H_2O. Mullite is obtained on firing the kaolin to 1400°. By means of the hydrothermal synthesis, the mullite yield is increased to about 43%. See also *Ceram. Abs.*, **12** [9], 343 (1933). M.V.K.

Vogtite, isomorphous with wollastonite. N. L. BOWEN. *Jour. Wash. Acad. Sci.*, **23** [2], 87–94 (1933).—If vogtite, a silicate of the general formula (Ca, Fe, Mn, Mg) SiO_3, is oriented so that the prism zone corresponds to the orthozone of wollastonite, a remarkable agreement appears between the angles and forms of the two species. Thus for wollastonite $a:b:c = 1.083:1:0.967$, $\alpha = 90°$, $\beta = 95°16'$, $\gamma = 103°25'$; for vogtite $a:b:c = 1.076:1:0.964$, $\alpha = 90°43'$, $\beta = 95°10'$, $\gamma = 103°35'$. There are strong reasons for believing that vogtite is a wollastonite solid solution. Bustamite may also be a wollastonite. J.B.A.

Quantitative separation of aluminium from iron. J. HASLAM. *Analyst*, **58**, 270–72 (1933).—Fe is precipitated as sulfide in ammoniacal tartrate solution, and after removal of sulfides from the filtrate Al is precipitated with 8-hydroxyquinoline. A brief bibliography of the precipitation of metals generally by 8-hydroxyquinoline is given. H.H.S.

Adsorption indicators in volumetric analysis (of lead and borates). A. W. WELLINGS. *Analyst*, **58**, 331–33 (1933).—The soluble Pb salt is run into standard NaOH, using fluorescein, dichlorofluorescein, or dibromofluorescein as indicators. Borates and perborates are neutralized to methyl red and then titrated with standard Pb acetate solution, using dichlorofluorescein as indicator. H.H.S.

Possible form of Si_3O_8 groups in silicates. TEI-ICHI ITO. *Proc. Imp. Acad.* [Tokyo], **9**, 53–55 (1933).—A model of an arrangement of the atoms of a silicate was built corresponding to the grouping Si_3O_8. There is no sharing of edges or of faces of tetrahedra SiO_4. The assumption of the complex chain (Si_3O_8) of partially linked tetrahedral groups of Si and O ions permits the prediction of certain properties that actually exist. (*C.A.*)

Freezing point of iridium. F. HENNING AND H. T. WENSEL. *Ann. Physik*, **17** [6], 620–34 (1933).—The freezing temperature was determined from the ratio of brightness of two black bodies immersed into freezing iridium and gold, respectively. Heating was done in a high-frequency furnace, the melts being contained in thoria crucibles and enclosed by layers of molten and pulverized thorium oxide. The freezing temperatures of platinum and iridium are 1773 ± 1°C and 2454 ± 3°C. W.M.C.

Determination of potassium by the cobaltinitrite method and its application in agricultural analysis. A. H. LEWIN AND F. B. MARMOY. *Jour. Soc. Chem. Ind.*, **52** [25], 177–82 (1933).—The application of the method to soil and plant extracts was studied and found suitable. Full details of technique are described. G.R.S.

New method for the microdetermination of magnesium. A. BLANCHETIÈRE AND M. ARNOUX. *Jour. pharm. chim.*, **17**, 97–107 (1933); *Analyst*, **58**, 305–306 (1933).—Mg is precipitated by hexamethylene-tetramine in the presence of KI as MgI_2, $10H_2O$, $2(CH_2)_6N_4$. H.H.S.

Activation of oxides by foreign oxides. RUDOLF SCHENCK AND HANS ROTERS. *Z. anorg. allgem. Chem.*, **211** [1–2], 65–82 (1933).—The oxygen pressure in a system consisting of two compounds in different states of oxidation is changed by the presence of foreign oxides which do not split off oxygen. The pressure is lowered if the higher oxidation state forms a solid solution or a chemical compound with the foreign oxide,

and it is increased if the solid solution or chemical compound is formed between the lower oxide and the foreign oxide. Thus Al_2O_3 lowers the tension in the system, $3MnO + CO_2 = Mn_3O_4 + CO$, and Al_2O_3 raises the pressure in the system, $2CeO_2 + CO = Ce_2O_3 + CO_2$. The effect of other oxides on the CeO_2 system was studied. L.T.B.

New conception of certain colloidal oxides. A. W. THOMAS. *Jour. Amer. Leather Chem. Assn.*, **28**, 2–24 (1933).—The micellar constitution of aluminium oxide sols is elaborated. A series of sols of the same total composition, but of different properties, is shown to exist. The differing results of various workers is thereby explained. H.H.S.

Problem of the solid state of matter. F. ZWICKY. *Mech. Eng.*, **55** [7], 427–32 (1933).—Z. discusses a new and general theory of the solid state which, for the first time, provides for an adequate framework in which all the essential physical properties of solids find their natural place. Illustrated with curves and sketches. F.G.H.

The collation of data. A. ALISON. *Glass*, **10** [7], 284–86 (1933).—Data represented by a straight line are discussed with regard to (1) the general equation, (2) determination of trial line, and (3) locating the "best line" by averaging. Illustrated. C.H.T.

BOOKS AND BULLETINS

Dictionary of General and Industrial Chemistry. Vol. I. A-E. (Dizinario di Chimica Generale e Industriale.) M. GUIA AND CLARA GUIA-LOLLINI. Urine Tipografico-Editrice Torinese (Utet), Turin, 1933. 1082 pp. Reviewed in *Jour. Phys. Chem.*, **37** [6], 825 (1933).—This is a first volume of a dictionary of chemistry concerned not only with the theoretical aspect of the science but also with its varied applications to agriculture, biology, geology, and mineralogy. This volume contains 28 tables and 565 illustrations. G.R.S.

Dictionary of Colloid Chemistry. (Wörterbuch der Kolloidchemie.) A. KUHN. 179 pp. Reviewed in *Chem. & Ind.*, **52** [18], 389 (1933); for abstract see *Ceram. Abs.*, **12** [8], 315 (1933). G.R.S.

Comprehensive Treatise on Inorganic and Theoretical Chemistry. Vol. XII. J. W. MELLOR. Briefly reviewed in *Nature*, **131** [3314], 638–39 (1933); see also *Ceram. Abs.*, **12** [5], 207 (1933). J.L.G.

Qualitative Chemical Analysis. R. K. MCALPINE AND B. A. SOULE. Reviewed in *Ind. Eng. Chem.*, **25** [7], 829 (1933); see also *Ceram. Abs.*, **12** [9], 343 (1933). F.G.H.

Elementary Quantitative Analysis. HOBART H. WILLARD AND N. HOWELL FURMAN. D. Van Nostrand Co., Inc., New York. 406 pp. $3.25. *Can. Chem. Met.*, **17** [7], 35 (1933).—In connection with each analytical method there is a discussion of the theoretical principles involved and the most likely sources of error. See also *Ceram. Abs.*, **12** [9], 343 (1933). E.J.V.

Stereochemistry. Vol. IV. (Stereochemie.) STEFAN GOLDSCHMIDT. Edited by A. Euken and K. L. Wolf. xiii + 311 pp. Akademische Verlagsgesellschaft m. b. H., Leipzig, 1933. 29 M. Reviewed in *Nature*, **131** [3318], 783–84 (1933).—This is a useful contribution to the literature of stereochemistry. J.L.G.

Stereochemistry. Edited by K. Freudenberg. Reviewed in *Nature*, **131** [3321], 563–66 (1933); for abstract see *Ceram. Abs.*, **12** [7], 282 (1933). J.L.G.

Unit Processes and Principles of Chemical Engineering. J. C. OLSEN *et al.* Macmillan and Co., London, 1932. 558 pp. Reviewed in *Chem. & Ind.*, **52** [18], 394 (1933); see also *Ceram. Abs.*, **12** [7], 286 (1933). G.R.S.

Physical Methods of Analytical Chemistry. I. Spectroscopic and Radiometric Analysis. (Physikalische Methoden der analytischen Chemie. I. Spektroskopische und radiometrische Analyse.) G. SCHEIBE, H. MARK, AND R. EHRENBERG. Akademische Verlagsgesellschaft, Leipzig, 1933. x + 388 pp. Price 36 M. Reviewed in *Ind. Eng. Chem.*, **25** [7], 830 (1933). F.G.H.

Physics: A Textbook for Students in Universities and Technical High Schools. (Physik: ein Lehrbuch für Studierende an den Universitaten und technischen Hochschulen.) WILHELM H. WESTPHAL. 3rd ed. xvi + 596 pp. Julius Springer, Berlin, 1933. 19.80 M. Briefly reviewed in *Nature*, **131** [3321], 895 (1933).—This edition enlarges on the second but at the same time it omits or compresses some less important material. Electrostatic and electromagnetic units are retained in preference to adopting international units. Thermoelectricity, electrolysis, and geometrical optics are less fully treated than electromagnetics, interference, and wave theory. Some parts are elementary and more advanced portions are treated only in outline. J.L.G.

Handbook of Experimental Physics. (Handbuch der Experimentalphysik.) Edited by W. Wien and F. Harms with the collaboration of H. Lenz. **Vol. IV. Hydro and**

Aërodynamics. Edited by L. Schiller. viii + 719 pp. Akademische Verlagsgesellschaft m. b. H., Leipzig, 1932. 67 M. Reviewed in *Nature*, **131** [3313], 602–603 (1933).—This fourth and final volume comprises three long articles on hydrodynamics and aërodynamics. These deal respectively with flow in pipes, flow in open channels, and the measurement of viscosity. J.L.G.

Physical Chemistry. J. EGGERT. Reviewed in *Chem. & Ind.*, **52** [17], 376 (1933); see also *Ceram. Abs.*, **12** [8], 315 (1933). G.R.S.

Textbook of Physical Chemistry. Vol. I. General Properties of Elements and Compounds. J. NEWTON FRIEND. Reviewed in *Chem. & Ind.*, **52** [18], 386 (1933); see also *Ceram. Abs.*, **12** [5], 207 (1933). G.R.S.

Results of Technical X-Ray Science. Vol. III. (Ergebnisse der technischen Röntgenkunde.) J. EGGERT AND E. SCHIEBOLD. Akademische Verlagsgesellschaft, Leipzig, 1933. 211 pp. Reviewed in *Z. Krist.*, **85** [3–4], 334 (1933).—The book contains 19 lectures given in 1932 before the German Society for X-Ray Science in Münster. The first 7 lectures, Part I, treat the "theory of the reciprocal action between X-rays and matter," the remainder in Part II describes newer apparatus and methods of technical X-ray science. G.R.S.

Chemical Analysis by X-Ray and Its Applications. G. VAN HEVESY. McGraw-Hill Book Co., London, 1932. Reviewed in *Chem. & Ind.*, **52** [18], 388 (1933); see also *Ceram. Abs.*, **12** [5], 207 (1933). G.R.S.

Applied X-Rays. G. L. CLARK. McGraw-Hill Book Co., New York, 1932. 2d ed. 470 pp. Price $5.00. *Mech. Eng.*, **55** [5], 331 (1933); *Jour. Inst. Metals*, **53** [3], 173 (1933); see also *Ceram. Abs.*, **12** [8], 315 (1933). F.G.H.

General Properties of Matter. F. H. NEWMAN AND V. H. L. SEARLE. 2d ed. Macmillan Co., New York, and Ernest Benn, Ltd., London, 1932. 388 pp. Price $4.00. Reviewed in *Trans. Faraday Soc.*, **29** [6], 724 (1933); *Mining & Met.*, **14** [320], 354 (1933).—The chapters include gravitation, gyroscopic motion, elasticity, surface tension, viscosity, kinetic theory, and osmosis. G.R.S.

History of the Microscope. R. S. CLAY AND T. H. COURT. Charles Griffin and Co., Ltd., 1932. 266 pp. Reviewed in *Trans. Faraday Soc.*, **29** [6], 722 (1933). G.R.S.

Crystal Chemistry of Inorganic Compounds. (Kristalchemie der anorganischen Verbindungen.) M. C. NEWBURGER. Ferdinand Enke, Stuttgart, 1933. Reviewed in *Jour. Phys. Chem.*, **37** [5], 658 (1933). G.R.S.

Lipoids and Ions. (Lipoide und Ionen.) A. DEGKWITZ. Steinkopff, Dresden and Leipzig, 1933. 323 pp. Reviewed in *Jour. Phys. Chem.*, **37** [6], 831–32 (1933).—This volume contains a general but readable account of the properties of surface films and the action of the forces responsible for surface tension in effecting a molecular orientation as well as affecting chemical equilibrium at interphases. In addition the more important properties of hydrophobic and hydrophilic colloidal systems are discussed. G.R.S.

Catalysis and Its Industrial Applications. E. B. MAXTED. J. and A. Churchill, London, 1933. 529 pp. Reviewed in *Chem. & Ind.*, **52** [27], 567 (1933).—The book is arranged in two parts, one theoretical and the other industrial. G.R.S.

Introduction to Mechanics and Acoustics. Vol. I. Introduction to Physics. (Einführung in die Mechanik und Akustik. Einführung in die Physik.) R. W. POHL. 2d improved ed. viii + 251 pp. Julius Springer, Berlin, 1931. 15.80 M. Reviewed in *Nature*, **131** [3321], 568 (1933).—The book is notable for its experimental illustrations and for the small demand it makes on the student's knowledge of mathematics. Illustrated. J.L.G.

Glass and Ceramic Filters in the Laboratory for Filtration, Gas Diffusion, Dialysis, and Extraction. (Glas- und Keramischefilter im Laboratorium für Filtration, Gasverteilung, Dialyse, Extraktion.) P. H. PRAUSNITZ. Akademische Verlagsgesellschaft, Leipzig, 1933. viii + 193 pp. Price 11.80 M. Reviewed in *Analyst*, **58**, 250 (1933); *Ind. Eng. Chem.*, **25** [7], 830 (1933).—The physical and chemical properties and the purification of glass and ceramic filters are described and illustrated. See also *Ceram. Abs.*, **12** [2], 56 (1933). F.G.H.

Handbook of Mathematical Tables and Formulas. R. S. BURINGTON. Handbook Publishers, Inc., Sandusky, Ohio, 1933. 251 pp. Price $2.00. Reviewed in *Ind. Eng. Chem.*, **25** [7], 829 (1933). F.G.H.

Colorimetry: Its Applications in Analytical Practice. HUGO FREUND. Translated by F. Bamford. 255 pp. E. Leitz, London, 1933. Price 10s. Reviewed in *Analyst*, **58**, 310–11 (1933). H.H.S.

Hydrogen-Ion Concentration and Its Practical Application. F. L. LA MOTTE, W. K.

KENNY, AND A. B. REED. 262 pp. Williams & Wilkins Co., Baltimore, 1933. Price $3.50. Reviewed in *Jour. Amer. Leather Chem. Assn.*, **28**, 306–307 (1933); see also *Ceram. Abs.*, **12** [9], 344 (1933). H.H.S.

Natural barium carbonate. FOOTE MINERAL CO. Reviewed in *Ceram. Age*, **21** [6], 186 (1933).—The source, preparation, and application of witherite are discussed in this bulletin. F.G.H.

Story of potash. AMERICAN POTASH AND CHEMICAL CORP. Reviewed in *Ceram. Age*, **21** [6], 186 (1933).—This booklet describes and illustrates the mining and processing of mineral deposits from which potash salts, borax, and boric acid are obtained. F.G.H.

PATENTS

Process for recovering potash salts from liquors containing borax. A. F. RITCHIE, W. A. GALE, AND W. H. ALLEN (American Potash & Chemical Corp.). U. S. 1,921,481, Aug. 8, 1933.

Process of making dry sodium aluminate. G. H. WAGNER (National Aluminate Corp.). U. S. 1,923,464, Aug. 22, 1933.

Process for the treatment of raw materials containing silicic acid or silicates and oxides of heavy or light metals. E. J. KOHLMEYER AND XAVER SIEBERS. U. S. 1,924,323, Aug. 29, 1933. A process for the treatment of materials containing at least one of the materials, silicic acid and silicates, and oxides of metals, comprises rapidly heating the materials in mixture with zinc sulfide and carboniferous substances to a sintering temperature of about 1350 to 1450°C, removing the silicic acid as silicon-subsulfide, and recovering the metal oxides from the residue.

Manufacture of alkali silicates or alkali-alkaline earth silicates. W. J. TENNANT (Henkel et Cie). Brit. 395,182, July 19, 1933.

Separation of iron and aluminium oxides. J. G. STEIN & CO., LTD., J. F. HYSLOP, AND R. MACKENZIE. Brit. 397,288, Aug. 30, 1933.

Preparation of chromates and dichromates. BOZEL-MALÉTRA SOC. INDUSTRIELLE DE PRODUITS CHIMIQUES. Brit. 397,434, Aug. 30, 1933.

General

Forty years of collegiate ceramic education and thirty-five years of the American Ceramic Society. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **12** [8], 241–42 (1933).

Teaching of glass technology. S. R. SCHOLES. *Bull. Amer. Ceram. Soc.*, **12** [8], 243–47 (1933).

Results of time studies in the manufacture of structural clay products. H. R. STRAIGHT. *Bull. Amer. Ceram. Soc.*, **12** [8], 248–52 (1933).

Utilizing waste products in the production of alumina from kaolin. P. P. BUDNIKOFF AND V. M. DOROFEEV. *Ukrain. Khem. Zhur.*, **7** [4], 185–88 (1932).—It has been found that waste product resulting from the production of alumina from kaolin according to the soda-lime method of Shmatko can be used (1) as an independent bonding agent, (2) as active addition to anhydrite and anhydrite-dolomite cement, (3) in Portland cement, and (4) as a component of glass batches. The chemical analysis shows that it is composed of 26.48% SiO_2, 7.59 Al_2O_3, 1.35 Fe_2O_3, 28.50 CaO, 1.97 K_2O, 13.18 Na_2O, and traces of MgO, with 20.72% loss on ignition. M.V.K.

Reformation of blue ultramarine from a colorless decomposition product. KURT LESCHEWSKI AND HEINZ MOLLER. *Z. anorg. allgem. Chem.*, **212** [4], 425–31 (1933).—In the usual synthesis of ultramarines there are many side reactions so that a pure product is not obtained. The authors attempted to avoid these impurities by synthesis from an amorphous decomposition product in which the Si, Al, and S were largely unchanged but only the alkali split off. By this procedure a definite reaction was traced which furnished some clew to the structure of ultramarines. L.T.B.

Action of hydrogen and oxygen on blue ultramarine. KURT LESCHEWSKI AND HEINZ MOLLER. *Z. anorg. allgem. Chem.*, **212** [4], 420–24 (1933).—On treating blue ultramarines with hydrogen and oxygen varying amounts of water are obtained; color changes from light to dark blue are observed simultaneously. L.T.B.

Method for preparing thallous hydroxide. R. PHILLIPS AND W. W. HARTMAN. *Jour. Amer. Chem. Soc.*, **55** [8], 3065–66 (1933).—The salts of thallium and an organic acid are useful in determining the specific gravity of ores and minerals. Thallium salts are prepared simply from thallous hydroxide and an organic acid or ester, the difficulty being the preparation of thallous hydroxide. A convenient method for the

preparation of the latter by the passage of steam and air through a tube containing thallium is described. F.G.H.

Cooling time in absorption tests. II. J. ANDRÉ LAVERGNE. *Rev. mat. constr. trav. pub.*, No. 284, pp. 86–89*B* (1933).—The penetration of water into a ceramic material takes place only during the period of cooling and while in cold water after boiling. The tested object expels, during heating, a part of the water which might have been absorbed when cold. The rate of penetration may be easily determined by weighing at different intervals. For Part I see *Ceram. Abs.*, **12** [3], 131 (1933). M.V.K.

Developing a method for viscosity measurements of open-hearth slag. E. DIEPSCHLAG AND F. K. BUCHHOLZ. *Arch. Eisenhüttenwesen*, **6**, 525–37 (1933).—From an examination of different methods for measuring the viscosity, the torsion method was found to be the most satisfactory one. Based on preliminary experiments an apparatus was built for plant control work. The apparatus was calibrated by means of one wetting and two nonwetting liquids. Preliminary data are presented on viscosity measurements as a base for the proper slag measurements. W.M.C.

Flame radiation in water-cooled boiler furnaces. ROYAL SWEDISH INST. FOR ENGINEERING RESEARCH. *Fuel Econ.*, **8** [91], 439–42; [92], 491–94 (1933); abstracted in *Mech. Eng.*, **55** [8], 511 (1933). F.G.H.

Chemical enrichment of quartz sand, clays, and kaolins. I. I. KITAIGORODSKII AND L. S. LANDI. *Keram. i Steklo*, **9** [5], 7–10 (1933).—Conditions in the chemical concentration of quartz sand, clays, and kaolins when treating them with gaseous chloric hydrogen and gaseous chlorine are discussed. Good results were obtained when treating these materials with gaseous chloric hydrogen at a temperature of 800 to 900°. Sand containing 2.07% Fe_2O_3 before the treatment contained only 0.03% after it. The treatment with gaseous chlorine was unsatisfactory. M.V.K.

Casting ceramic products with thick walls. J. MICHEL. *Keram. Rund.*, **41** [21], 269–70 (1933); abstracted in *Feuerfest*, **9** [6], 92 (1933).—M. discusses details in the production of mixes for special grog bodies, stoneware, rinsing ware, vitreous china, etc., including (1) molding, (2) working of the mix, (3) its consistency, (4) use of active electrolytes, (5) methods utilized according to the behavior of the slip, and (6) deairing. M.V.K.

Removal of iron from clay by skin flotation. M. C. SHAW. *Ceram. Ind.*, **21** [2], 88 (1933).—Skin flotation is effected by the selective adsorption of some oil or flotation medium by the pyrite in clay. This adsorption causes the iron to float to the surface where it forms a film of oil carrying the pyrite. The clay, not having the property of adsorbing this flotation oil, drops out of the oil phase into the water phase. The more important precautions of the operation are as follows: (1) the iron to be floated must not be coarser than 100-mesh; (2) the rotation of the mill must be fairly slow and not more than 20 r.p.m.; and (3) the slime must not be any thicker than 1 clay, 3 water. E.J.V.

Recovery by flotation of mineral particles of colloidal size. A. M. GAUDIN AND P. MALOZEMOFF. *Jour. Phys. Chem.*, **37** [5], 597–607 (1933).—Hypotheses were considered to account for the nonflotation of colloidal particles. Selective flocculation of colloidal mineral makes its flotation more complete and easier. Flotation of colloidal sulfide mineral particles may be successfully accomplished by using as reagents certain heteropolar sulfur-bearing organic substances. G.R.S.

Dust in industry. J. J. BLOOMFIELD. *Mech. Eng.*, **55** [4], 229–62 (1933).—The properties of a dust which determine its capacity to produce pulmonary pathology are (1) the nature of the dust, its chemical and mineralogical composition, (2) its particle size, and (3) the quantity of the dust dispersed in the atmosphere. B. describes the underlying factors involved and the technique employed in the sampling and analysis of industrial dusts which may produce injury to the respiratory system. Illustrated. F.G.H.

Recent experiences of silicosis in the pottery industry. A. MEIKLEJOHN. Presented at meeting of the National Council of the Pottery Industry, Stoke-on-Trent, July, 1933; *Pottery Gas.*, **58** [674], 955–61 (1933).—The routine medical examination of certain scheduled workers in the pottery industry is defended. E.J.V.

Silicosis and the metabolism of silicic acid. E. J. KING. *Can. Chem. Met.*, **17** [7], 146–47 (1933).—The "colloidal theory of silicosis" and the biochemistry of silica as investigated by K. are reported upon. E.J.V.

Meeting of the Ceramic Association of New Jersey. ANON. *Ceram. Age*, **22** [1], 9 (1933).—The June meeting was featured by an extensive report on silicosis. F.G.H.

Prevention of industrial diseases of the skin. H. HALDEN-DAVIS. *Chem. &*

Ind., **52** [28], 575–78 (1933).—The chief industrial diseases of the skin are (1) anthrax, (2) cancer of the skin, and (3) trade dermatitis. A short résumé of the measures recommended by public authorities and adopted and developed by manufacturers for their prevention is given. C.H.T.

Modern chemical plant. J. A. REAVELL. *Jour. Soc. Chem. Ind.*, **52** [20], 133–39 (1933).—The following topics are treated: (1) direct electric heating, (2) fluid heat transmission with electricity as the source of heat, and (3) classification and drying suspensions. G.R.S.

Winning and transporting of clay. FRANK WEST. *Pottery Gaz.*, **58** [674], 974–75 (1933); see also *Ceram. Abs.*, **12** [9], 336 (1933). E.J.V.

Porcelain enamelers would stabilize their industry. ANON. *Ceram. Age*, **21** [6], 166 (1933).—The program of the Porcelain Enamel Institute for the stabilization of the porcelain enamel industry is described. F.G.H.

Industry coöperation. RUDOLF W. STAUD. *Better Enameling*, **4** [6], 18–19 (1933).—A memorandum on the subject of self-regulation and the elimination of unfair methods of competition in the porcelain enameling industry is presented. E.J.V.

What's the matter with the tile business? D. P. FORST. *Ceram. Age*, **21** [6], 167–68 (1933).—The difficulties and evils surrounding the production and distribution of tile are thoroughly discussed. The need for research in the production of noncrazing tile, in the installation of tile, and in the public comparison of tile with its competitors is emphasized. F.G.H.

Basic structure of the ceramic industry. A. V. BLEININGER. *Clay-Worker*, **100** [1], 20 (1933); see also *Ceram. Abs.*, **12** [9], 345 (1933). E.J.V.

Objectives for Belgian research laboratories. ANON. *Rev. belge ind. verrières, céram., émail.*, **4** [1], 3–4 (1933).—The article urges national spirit, comparable with France and surrounding nations, in the use of technical and artistic skill in Belgian production of ceramic ware and urges that research work be directed to that result. P.E.C.

Meeting of the German Glass Technical Society. ANON. *Glastech. Ber.*, **11** [3], 85–104 (1933).—Some of the papers read and raw materials and apparatus exhibited at the January, 1933, meeting in Berlin are described. M.V.K.

Rutgers Third Ceramic Exposition. ANON. *Ceram. Age*, **21** [6], 170 (1933).—Illustrations portray the recent exposition held by the Ceramic Dept. of Rutgers Univ. and the Ceramic Assn. of New Jersey. F.G.H.

Highlights of ceramics at "A Century of Progress." ANON. *Ceram. Age*, **22** [1], 6–7 (1933).—Two illustrated pages of ceramic exhibits are presented. F.G.H.

Universal exhibition of glass in Prague. ANON. *Chem. & Ind.*, **52** [28], 586 (1933).—A description is given of what is claimed to be the largest exhibit of antique and modern glassware ever shown in Europe. Medieval, 17th Century, and present-day types of glass are separately exhibited. C.H.T.

BOOKS AND BULLETINS

Reports of the Progress of Applied Chemistry. Vol. XVII. Society of Chemical Industry, London, 1932. 721 pp. *Jour. Inst. Metals*, **53** [3], 176 (1933). F.G.H.

Industrial Chemistry. W. H. READ. John Wiley and Sons, Inc., New York, 1933. vii + 576 pp. Price $5.00. Reviewed in *Ind. Eng. Chem.*, **25** [8], 947–48 (1933). F.G.H.

Berl-Lunge Chemico-Technical Research Methods. Vol. III. Edited by E. Berl. Reviewed in *Chem. & Ind.*, **52** [18], 395–96 (1933); for abstract see *Ceram. Abs.*, **12** [7], 281 (1933). G.R.S.

Introduction to Industrial Management, Text, Cases, and Problems. E. C. ROBBINS AND F. E. FOLTS. McGraw-Hill Book Co., New York, 1933. 356 pp. Price $3.00. *Mech. Eng.*, **55** [5], 332 (1933). F.G.H.

Thermodynamics. J. E. EMSWILER. McGraw-Hill Book Co., New York, 1932. 347 pp. Price $3.00. Reviewed in *Mech. Eng.*, **55** [5], 333 (1933). F.G.H.

Vocational Guidance in Engineering Lines. AMER. ASSN. OF ENGINEERS. Mack Printing Co., Easton, Pa., 1933. 521 pp. Price $2.50. Reviewed in *Ind. Eng. Chem.*, **25** [8], 947 (1933).—A chapter on ceramic engineering is included in this vocational guide for the various fields of engineering. F.G.H.

The Technical Man Sells His Services. E. HURST. McGraw-Hill Book Co., Inc., New York, 1933. 239 pp. Price $2.00. Reviewed in *Ind. Eng. Chem.*, **25** [8], 947 (1933). F.G.H.

Blasting practices as they affect the roofs of coal mines in Ohio, Pennsylvania, and West Virginia. J. N. GEYER. Bur. Mines *Information Circ.*, No. 6738. 11 pp. Free. R.A.H.

Timber withdrawing and devices used for this purpose in coal mines. J. W. PAUL AND J. G. CALVERLEY. Bur. Mines, *Information Circ.*, No. 6722. 15 pp. Free. R.A.H.

Book Review

Investigations in Ceramics and Road Materials, 1930 and 1931. Can. Dept. Mines, Mines Branch *Rept.*, No. 726. 175 pp. The report is divided into five parts as follow: (1) Ceramic bodies for electrical heating devices, by L. P. Collin; (2) Color control of brick, by L. P. Collin; (3) Roofing-tile clays and shales of eastern Canada, by J. F. McMahon; (4) Production of shapes from soapstone dust, by J. G. Phillips; and (5) Continuation of the investigation of the treatment of clays to overcome drying defects, by J. G. Phillips. G.R.SHELTON

PATENTS

Production of shaped articles from masses containing silicon. HANS HAEUBER (I. G. Farbenind. A.-G.). U. S. 1,916,836, July 4, 1933. A process for the production of shaped masses from metallic silicon comprises mixing metallic silicon with a ceramic material sintering below 100°C, heating the mixture obtained to a temperature above the sintering temperature of the ceramic material but below 1000°C, imparting to the obtained mass the desired shape by a mechanical operation, and heating the shaped mass to a temperature between 1000°C and the melting point of the metallic silicon contained therein.

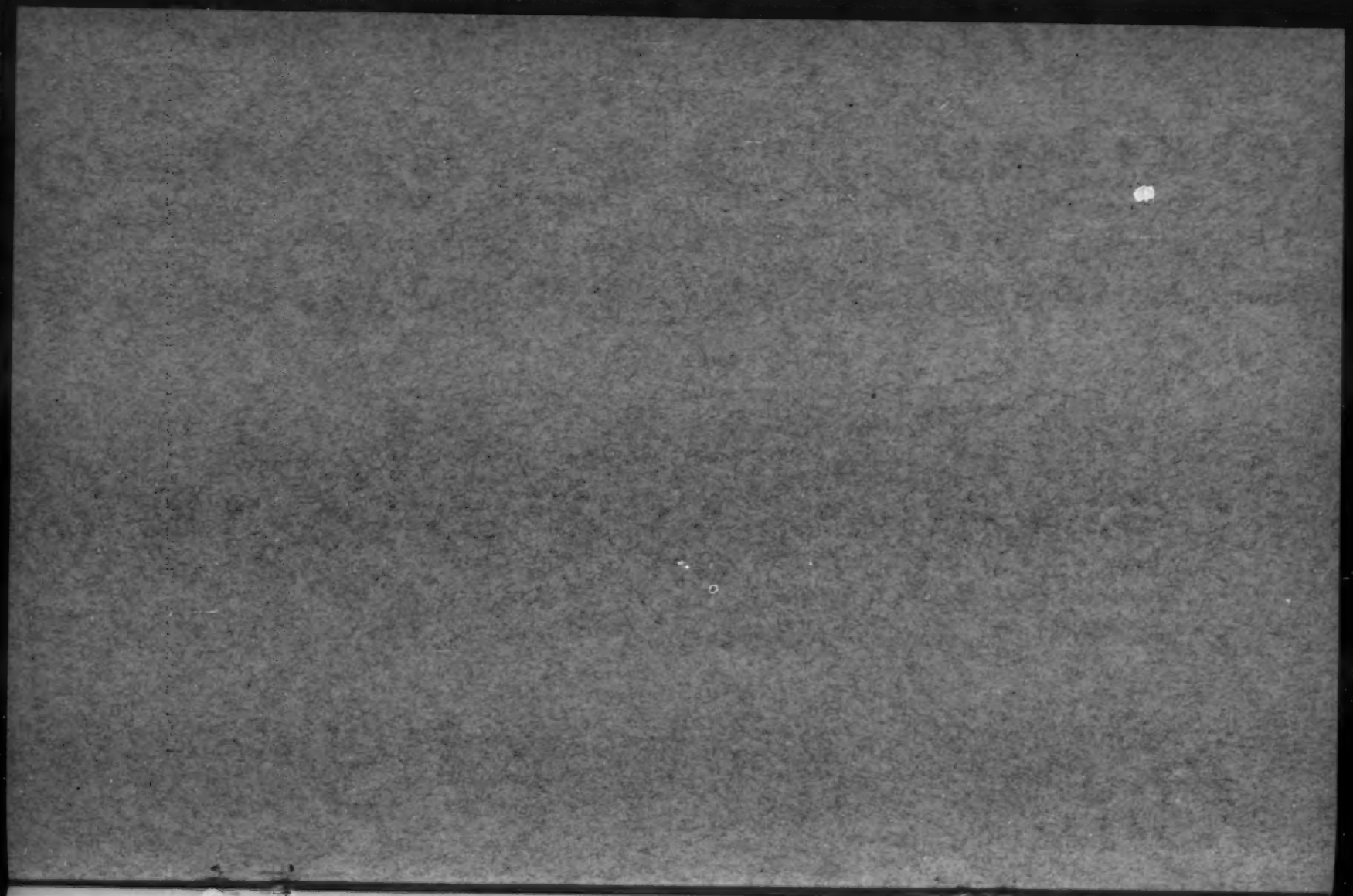
Method of manufacturing ceramic products. HUGO ACKERMANN (Didier-Werke Akt.-Ges.). U. S. 1,917,181, July 4, 1933. The method of manufacturing ceramically bonded products consists in mixing disintegrated leaning or nonplastic matter adapted to be bonded by clay with finely ground raw flint clay, water, and matter having liquefying action on the flint clay, molding the uncastable composition thus obtained, and firing it.

Method of manufacturing silicates with base-exchanging properties or so-called artificial zeolites. A. R. WIBERG AND P. M. E. SCHÖN (Reymersholms Gamla Industri Aktiebolag). U. S. 1,918,361, July 18, 1933. The method of manufacturing artificial zeolites is characterized in that waste clay obtained in the manufacture of aluminium salts by decomposition of a substance of the group consisting of natural aluminium silicates, bauxite, and refractory clays by means of a strong acidic compound is boiled under pressure in an aqueous mixture containing at least one basic oxygen compound of an alkali-forming metal.

Art of coloring mineral matter. H. L. SMALL (Philip Carey Mfg. Co.). U. S. 1,921,010, Aug. 8, 1933.

Granular material and method of making. R. L. ATKINSON (Empire Trust Co.). U. S. 1,925,065, Aug. 29, 1933. The method of preparing colored granules comprises the steps of reducing a compact, finely porous argillaceous material to granular form, developing the hardness thereof by heating without substantial reduction of porosity, treating the hardened granules with a solution of a mineral coloring agent to produce absorption of the coloring matter therein, and heating the treated granules to fix the coloring agent therein.

Method and apparatus for treating china clay, etc. S. BURGESS (W. Hertzsch). Brit. 393,447, June 14, 1933.

Supports for the roof, sides, and floor of mines, tunnels, etc. J. H. STEWART, W. REID, R. SCOTLAND, AND R. L. P. BELL. Brit. 395,877, Aug. 2, 1933.

Refining kaolin, clay, etc. ERICH NOACK AND EDUARD BACH (I. G. Farbenind. A.-G.). Ger. 575,395, April 27, 1933. When ceramic raw materials such as kaolin and clay are bleached with Cl they tend to lose some of their valuable properties, particularly plasticity. This disadvantage is now overcome by mixing the bleached material with a small proportion of unchlorinated material of the same or a similar kind. Thus, bleached kaolin may be mixed with 2 to 5% of naturally white plastic kaolin or a mixture of talc and kaolin. (*C.A.*)